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MAINTENANCE DREDGING OF THE FEDERAL NAVIGATION CHANNELS IN THE --ETC(U)
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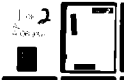

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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

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SUMMARY

MAINTENANCE DREDGING OF THE FEDERAL NAVIGATION CHANNELS IN THE SAGINAW RIVER AND SAGINAW BAY, MICHIGAN

( ) DRAFT ENVIRONMENTAL STATEMENT

(X) FINAL ENVIRONMENTAL STATEMENT

RESPONSIBLE OFFICE: U.S. ARMY ENGINEER DISTRICT, DETROIT
150 Michigan Avenue
Detroit, Michigan 48226
Telephone: (313) 226-7407

1. NAME OF ACTION: (X) ADMINISTRATIVE ( ) LEGISLATIVE

2. DESCRIPTION OF ACTION: The proposed project is to perform maintenance dredging of the Saginaw River and Saginaw Bay Federal Navigation channels. Dredging will be performed by a Government-owned hopper dredge. Approximately 140,000 cubic yards of polluted material dredged from the river, from the Detroit and Mackinac Railroad Bridge to the upper limits of the harbor, is placed on the confined disposal area on Middle Ground Island. The polluted channel section from the D&M R.R. bridge to the river mouth and the section throughout the inner bay will not be dredged until a confined disposal site is constructed to contain this dredged material. The average annual volume of shoaling throughout the project is approximately 640,000 cubic yards.

3. A) ENVIRONMENTAL IMPACT. The proposed continuance of maintenance dredging operations would sustain a deep water channel approximately 36 miles in length from the 27 foot contour in Saginaw Bay to a point 22 miles upstream of the mouth of the Saginaw River. Without such periodic maintenance work the channel area would eventually return to depths characteristic of the remainder of the bay and river. Maintenance dredging of the Federal Navigation Channels would restore authorized project depths enabling cargo vessels to utilize maximum draft loads with subsequent economic benefit. The resuspension of sediments associated with the removal operations would have a negative influences of varying degree upon the adjacent aquatic environment. No adverse effects associated with open-lake disposal would be incurred since polluted sediments would be placed in confined disposal facilities. Construction of a contained disposal facility for polluted dredged materials from Saginaw Bay navigation channel, Bay County, Michigan, will create 355 acres of upland in Saginaw Bay, replacing two small islands created by former dredging, and the surrounding bay bottomland and water. This is a commitment of a water resource to another use, loss of associated aquatic communities, and a change in the

hydraulic regime. It is expected the prospective island landform will create minor changes in the latter and short-term losses in the former, with long-term reinstatement of comparable if not improved values: potential re-establishment of fish habitat in rock dike; upgrading of water quality in bay and Lake Huron through removal of considerable quantities of polluted bottom sediments; creation of a protected area in the bay to the lee of the island for present users of the area; elimination of continuing erosion from present spoil islands, a source of turbidity and channel shoaling; creation of a potential recreation area with resultant increased use of water resources of the bay for people and area wildlife. Resumption of dredging will restore channel project depths and insure safe navigation without loss of shipping capacity which is of significant economic importance to the region and area.

3. B) ADVERSE ENVIRONMENTAL EFFECTS. Since bottom sediments of the Saginaw River and the inner areas of the shipping channels in Saginaw Bay are classified as polluted by the Environmental Protection Agency with respect to COD, volatile solids, total Kjeldahl nitrogen and zinc, it can be expected that some of these parameters will affect local water quality in the dredging area as the activity progresses. Temporary fluctuations in water quality should remain localized and create minor impacts in channel areas. Fish will avoid areas of dredging activity as dissolved oxygen levels decrease. Benthic organisms and any rooted aquatic plants in the channel areas will be removed by the proposed work. An irretrievable loss of approximately 200 acres of Saginaw Bay bottomland and open water, with associated aquatic communities, will occur with the construction of a contained disposal facility in Saginaw Bay. The stone facing of the dike provides a stable substrate for such nuisance growths as Cladophora, a filimentous algae.

4. ALTERNATIVES TO THE PROPOSED ACTION:

A. Dredging Alternatives

Alternative Dredge Types
Discontinue Maintenance Dredging (No Action)
Dredging to a Lesser Depth
Watershed Management

B. Disposal Alternatives

Confinement of All Materials
All Open Water
Upland Disposal
Pretreatment

C. Alternative Sites for the New CDF

5. A) COORDINATION WITH OTHERS:

5.1 The following governmental and other agencies have been contacted during the preparation of this Environmental Statement:

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Ocean Survey
Water Levels Branch
Lake Survey Center
Detroit, Michigan

Consumers Power Company
Environmental Department
Jackson, Michigan

Dow Chemical Company
Midland Division
Waste Control Department
Midland, Michigan

U.S. Environmental Protection Agency
Region V
Chicago, Illinois

Great Lakes Research Division
Institute of Science and Technology
Ann Arbor, Michigan

5. B) COMMENTS RECEIVED:

5.2 A Public Notice dated 12 February 1975 regarding annual maintenance dredging of the Federal navigation channels in Saginaw River, Michigan in 1975 and subsequent years was issued by the Corps' Detroit District Office. Copies of this notice were sent to the Environmental Protection Agency, the Department of the Interior, the U.S. Coast Guard, the State of Michigan, the Department of Commerce, Saginaw County, Bay County, the City of Essexville, and other Federal, State and Local agencies, as well as to known interested groups and individuals. Responses to this notice were received from the Department of Commerce, the Department of the Interior, the U.S. Coast Guard, the State of Michigan Department of Natural Resources and the U.S. EPA.

5.3 Comment on the Draft Environmental Statement were received from the following organizations:

Advisory Council on Historic Preservation
U.S. Department of Interior
U.S. Environmental Protection Agency
Federal Highway Administration, U.S. Department of Transportation
Forest Service, U.S. Department of Agriculture
Soil Conservation Service, U.S. Department of Agriculture
Michigan Department of State Highways and Transportation
Michigan Department of Natural Resources
Michigan Department of State
Saginaw-Midland Water Supply System

6. DRAFT STATEMENT TO CEQ ON 22 August 1975.

7. FINAL STATEMENT TO CEQ ON 22 June 1976 .

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MAINTENANCE DREDGING OF THE
FEDERAL NAVIGATION CHANNELS IN THE
SAGINAW RIVER AND SAGINAW BAY, MICHIGAN

1. PROJECT DESCRIPTION

A. Proposed Action

1.01 The proposed project is to perform annual maintenance dredging of the Saginaw River and Saginaw Bay Federal Navigation Channels in 1976 and in each subsequent year as required to remove shoaling (see Figure 1 on page 36). The U.S. hopper dredge HAINS is scheduled to dredge Saginaw River and Saginaw Bay Federal navigation channels during the period 20 July through 11 September 1976. This 54 day period is based on a 6 day week, operating 3 shifts a day.

B. Authority

1.02 Maintenance dredging of the navigable waterways in the United States is authorized to assure safe channel depths for waterborne commercial navigation and has been assigned to the U.S. Army Corps of Engineers by Congress. Specific Congressional authorizations for maintenance of channels covered by this statement are included in the River and Harbor acts of June 25, 1910, July 3, 1930, August 26, 1937, June 20, 1938, September 3, 1954, October 23, 1962, and October 27, 1965. These acts provide for an entrance channel 27 feet deep and 350 feet wide from the 27 foot contour in Saginaw Bay to the river mouth; thence a channel 26 feet deep and 200 feet wide for 0.4 mile; thence 25 feet deep and 200 feet wide to the New York Central Railway Bridge at Bay City; thence 22 feet deep and 200 feet wide to a point 2800 feet upstream from the Sixth Street Bridge in Saginaw; thence 16.5 feet deep and 200 feet wide to the upstream limit at Green Point. The project also provides for five turning basins; one 25 feet deep at Essexville, 600 feet wide with a maximum length of 1850 feet; one 22 feet deep on the east side of the channel about one mile upstream from Cass Avenue in Bay City, 650 feet wide and 1000 feet long; one 20 feet deep at Carrollton, 100 to 300 feet wide and 900 feet long; one 20 feet deep on the east side of the channel just upstream from the Sixth Street Bridge in Saginaw, 650 feet wide and 1000 feet long; and one 15 feet deep between the Bristol Street and New York Central Railway Bridges in Saginaw.

C. Project

1.03 The Federal project consists of a navigation channel

approximately 36 miles in length, extending from deep water in Saginaw Bay, Lake Huron to a point on the Saginaw River 22 miles upstream of the mouth. Several turning basins, as described in Paragraph 1.02, are also included in the river portion. The material to be dredged consists primarily of sand, silt and clay. The average annual volume of shoaling throughout the entire project is about 850,000 cubic yards.

1.04 Investigations into the sediment quality of the Saginaw River and Bay channels in 1970 by the Environmental Protection Agency revealed that bottom materials from the upstream limit of the project to five miles lakeward of the river mouth were polluted. Parameters that exceeded EPA standards included volatile solids, COD, total Kjeldahl nitrogen and oil and grease. As a result, dredging of polluted areas in Saginaw Bay was suspended in 1970, pending construction of a confined disposal facility. Additional 1975 sediment data indicated that sediments twelve miles lakeward of the river mouth are polluted. Sediments totalling a four year dredging backlog of approximately 43,000 cubic yards as of June 1975, and projected annual average volumes of 11,000 cubic yards, in the remaining three miles of the bay channel are presently being analyzed for their pollutional status. If determined to be polluted, these materials will also be disposed of in the confined disposal facility. If the channel sediments are unpolluted, they will be disposed of in the open waters of Saginaw Bay approximately 12 miles NNE of the Saginaw River mouth. Present scheduling calls for the disposal site to be ready to receive polluted dredgings in the fall of 1978.

1.05 Maintenance operations will continue in the Saginaw River channel concurrent with the construction of the new confined disposal site in Saginaw Bay. The proposed containment facility will encompass an area approximately 355 acres in size. This includes replacing two islands, Shelter and Channel, created by channel dredging as well as the open water surrounding the islands. The proposed site is located on the southeast side of the shipping channel in Saginaw Bay approximately two miles from the mouth of the Saginaw River. The shape of the new island will be irregular, though generally circular in order to create a more pleasing, natural area. The dikes will have a top elevation of 14 feet above Low Water Datum (576.8 feet) and extend 14,000 feet around the perimeter of the island. The facility will have a capacity for 12 million cubic yards of dredged material, the estimated amount for 10 years of annual maintenance dredging and accumulated backlog.

1.06 Approximately 140,000 cubic yards of polluted material dredged from the river, from the Detroit and Mackinaw Railroad Bridge to the upper limits of the harbor, is placed in the confined disposal area on Middle Ground Island. Presently, the City of Bay City removes approximately 100,000 cubic yards of material from the diked disposal facility, located on Middle Ground Island, by truck to a ski hill it is building. This ski hill is also located on Middle Ground Island approxi-

mately 1/4 to 1/2 mile south of the diked disposal facility. The ski hill is presently being constructed of alternate layers of city refuse and dredged materials. The city will cover the hill with a 5 foot layer of clay, seed and landscape to fulfill a Michigan Department of Natural Resources permit requirement. As indicated, the estimated life expectancy of the Middle Ground Island diked disposal facility is 2 to 3 years--the time anticipated as necessary for the city to complete its construction activities on the ski hill.

1.07 The polluted channel section from the D&M R.R. Bridge to the river mouth and the section throughout the inner bay will not be dredged until a confined disposal site is constructed to contain this dredged material. Figures 1 and 2 depict the Saginaw River and Saginaw Bay navigation channels and proposed dredge disposal sites. An Environmental Assessment followed by both a Draft and a Final Environmental Impact Statement for the referenced proposed "Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan" were prepared by the U.S. Army Engineer District, Detroit. Preparation of the referenced Environmental Assessment of Alternate Sites was completed in February, 1974. The DEIS for the Shelter-Channel Island disposal site was filed with CEQ on 18 December 1974 and sent to the public and various interested agencies and officials on 19 December 1974. The FEIS was filed with CEQ on 29 May 1975 and sent to the public and various interested agencies and officials on 11 June 1975. Copies of the FEIS may be obtained from:

U.S. Army Engineer District, Detroit
150 Michigan Avenue
Detroit, Michigan 48226
Attn: Environmental Resources Branch

D. Procedure

1.08 Prior to any dredging operation, certain preliminary investigations are necessarily performed. A survey of a proposed dredging area is undertaken to determine the physical, chemical and engineering characteristics of the material as well as its pollutional status. Soundings are taken and the amount of material to be removed is calculated. Charts are marked with specifications indicating all dredging aids including buoys, towers and lights as well as depths and limits to be observed for navigation. After samples and field data from the project area are analyzed and evaluated physically, chemically and hydraulically, the proper dredge is selected with respect to limitations on size, draft, draghead, adapters, scrapers, speed, displacement, dredging depth and power, and effect of dredge type on the environment.

1.09 Dredging by the Corps of Engineers in the Saginaw River and Saginaw Bay will be done with a hydraulic-type dredge. A hopper dredge is a particular type of hydraulic dredge which suctions channel-bottom

materials into storage hoppers onboard in the hold where they are contained as a slurry (mixed sediments and water) during transport to a disposal site removed from the dredging location. This particular type of dredge does not have a rotating cutter head.

1.10 The hopper dredge used for this project will be within the size range of the Dredge HAINS and the Dredge MARKHAM. The HAINS is 310 feet long with a beam of 48 feet and has a draft of 9'5" when light and 13 feet loaded. The MARKHAM is 339 feet long with a beam of 62 feet and has a loaded draft of approximately 20 feet. Each dredge contains four hoppers with aggregate storage of 885 cubic yards on the HAINS and 2,681 cubic yards on the MARKHAM.

1.11 The hopper dredge Hains has two 18 inch diameter suction pipes, one located on each side of the vessel. The hopper dredge MARKHAM has two 24 inch diameter suction pipes; one located on each side of the vessel. During dredging operations, the pipes are lowered to a predetermined depth and bottom materials are pumped into the dredge hoppers until the desired density is reached. The hopper load in terms of density is known as "bin measure", a mixture of sediments and water.

1.12 While the dredge hoppers are being filled, heavy matter settles to the bottom while water fills the top portion of the hopper. This top water can be spilled overboard while the desired density of fill is being reached or until it becomes turbid. Excessively turbid water is retained for dumping with the material into the disposal area.

1.13 Dredge unloading may be accomplished in two ways. Large doors at the bottom of the hoppers can be opened for dumping into designated areas on the lake bottom. Prior to dumping, the chances of leakage through these doors when they are closed are slight. The River and Harbor Act approved by Congress in 1970 recognized a concern for water quality degradation resulting from the open lake dumping of polluted dredge materials. Therefore a second method, now used for disposal of polluted material, involves coupling a pipe from the dredge to one leading to a diked disposal area.

1.14 Dredging itself is relatively silent. When material is being unloaded, a slight noise will be heard in the vicinity in connection with the work during each unloading period. The noise involves not only the ship's engines pumping but the sound of sand, rocks and other material traveling through the pipes and discharging into the disposal site.

E. Federal Costs

1.15 Costs for the completion of the Saginaw Federal Navigation Channels are as follows (as of 30 June 1974):

	Existing Project	Previous Project
New Work	$13,954,571 (1)	$962,556

(1) Excludes $13,600 contributed funds

Federal expenditures for maintenance dredging of the navigation channels in Saginaw River and Bay have totaled $6,238,021 as of 30 June 1974. The estimated cost for construction of the Channel-Shelter Islands disposal facility is estimated to be 20 to 30 million dollars. Average maintenance dredging costs are currently at $ .95 per cubic yard using open-lake disposal versus $1.02 per cubic yard for confined disposal. This cost figure does not include amortization of construction expenditures for the confined disposal facility.

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

A. Regional

2.01 The Saginaw River System drains an approximate 6,200 square miles of land area in the east-central portion of the lower peninsula of Michigan. This total drainage area makes the Saginaw the largest river system in the state. The Saginaw River itself, directly drains an area of 246 square miles. The Cass, Flint, Shiawassee and Tittabawassee Rivers, which are tributary to the Saginaw, account for the remaining drainage area of the Saginaw System (Water Resources Comm., 1971).

2.02 The Saginaw River is formed by the Shiawassee and Tittabawassee Rivers at their confluence near the southern limit of the City of Saginaw. The Cass and Flint Rivers enter the Shiawassee just above this juncture. From its origin, the Saginaw River flows generally northeast for approximately 22 miles where it enters Saginaw Bay. Throughout its course, the river drops only two feet and consequently is a slow-moving stream.

2.03 Saginaw Bay is a shallow inland projection of the western shore of Lake Huron which forms the "thumb" of the lower peninsula of Michigan. The Bay is 26 miles wide at its entrance from Lake Huron between Point Aux Barques and Au Sable Point and approximately 51 miles long from its entrance to the mouth of the Saginaw River (Figure 3). The Bay is constricted at its mid-region between Lookout and Sand Points. A line drawn between these points separates the bay into two regions which equally divide its surface area of 1,143 square miles. The two regions are referred to as the inner and outer bays (Freedman, 1974). The inner bay is characteristically shallow having a mean depth of 15 feet and maximum depth of 46 feet. The outer bay is much deeper with a mean depth of 46 feet and a maximum of 133 feet.

2.04 Several islands are located within the bay, the most conspicuous of which are the Charity Islands located in the mid-region of the bay. The low-lying, marshy islands of North, Stony and Katechay are situated southwest of Sand Point and just northeast of the Sebewaing River mouth. Two additional islands worthy of note are Channel and Shelter Islands located just lakeward of the Saginaw River mouth. These two islands were created in the late 1960's as the result of the disposal of bottom materials during dredging and deepening of the adjoining shipping channel.

2.05 Geology. Surface deposits around Saginaw Bay and the Saginaw River are mainly of glacial or lacustrine origin. Following the last advance of the Pleistocene Ice, the area was covered by glacial Lake Saginaw. As the lake receded to present levels, lacustrine and morainic deposits remained which typify the surface geology of the region today.

2.06 Beneath the glacial and lacustrine materials, the Saginaw River and Saginaw Bay are underlain by bedrock of the Grand River and Saginaw Formations, the Grand Rapids Group, Marshall Sandstone, and Coldwater Shale. These rock-types are primarily sandstone, limestone and shale with some coal and represent the preglacial Mississippian and Pennsylvanian geologic periods.

2.07 Middle Ground Island was a low marshy island whose original general soil composition was mud and river silt down to about 40 foot depth where those materials contact clay. The island has been used for years as a land fill, and has been built up to its present elevations utilizing alternating layers of refuse, silt, sand and clay.

2.08 The Channel-Shelter Island area is of relatively shallow water depth. The deepest portion in the area to be diked is approximately fourteen feet below the water surface. Islands located in this area were formed as the result of dredging in the shipping channel. The composition of the strata that the disposal site is to be built on is mostly fine sands and silts. Borings at the site will be taken before final design of the dike. Dikes built on dredge spoils at other locations have experienced minor mud flows as the dike material displaces the softer surface sediments and stabilizes itself on the lower harder layers. The final dike design will best meet the requirements of the soils, strata and wave conditions that are revealed through careful testing and sampling.

2.09 Hydrology. Saginaw Bay is the natural, prominent hydrologic feature of the region with its primary tributary being the Saginaw River. Actually, Saginaw Bay receives runoff from a basin seven times larger than the bay itself, a total in excess of 8,000 square miles (Freedman, 1974).

2.10 Water levels in the bay are presently high. As of March 1975, the monthly mean water level at Essexville, Michigan was 579.54 or 2.74

feet above the International Great Lakes Datum (IGLD) 1955 (USDC, NOAA, 1975). Saginaw Bay, as an extension of Lake Huron, follows the water level pattern of the Michigan-Huron System. Michigan-Huron mean water levels have shown a rising trend since 1964 at which time a mean level of 575.37 was recorded for the month of April at Harbor Beach, Michigan (USDC, NOAA, 1974).

2.11 In addition to normal, seasonal fluctuations in water level, Saginaw Bay experiences short-term rapid fluctuations as well. The bay is subject to wave runup, wind driven tides, storm surges and seiches as meteorological conditions dictate. Such occurrences can cause changes in water level amounting to a few feet for short periods of time.

2.12 The current patterns of Saginaw Bay and Lake Huron have been studied by Ayers, et. al. (1956) and Johnson (1956). Their studies and conjectures indicate the primary circulation pattern of the bay to be counterclockwise; however, the effects of locally induced wind stress and resultant changes in the general pattern are clearly evident from their studies of surface currents. Lake Huron water enters the bay along its northwest shore and re-enters the lake along the northeast shore. The Saginaw River, the bay's most substantial input source, turns southeasterly as it enters the bay to join the predominant counterclockwise circulation pattern. Sediment studies have shown Saginaw River materials largely deposited along the bay's southeast shore, further confirming the predominant circulation pattern of the system (Wood, 1964).

2.13 Thermal patterns in Saginaw Bay follow an annual temperature cycle mainly typical of a north temperate zone lake. The deep water temperatures remain at or near 39°F throughout the year (Freedman, 1974). Surface waters undergo temperature changes as seasonal influences affect the system. Temperature stratification does occur in the bay; however, primarily in the outer portion. During winter months ice completely covers Saginaw Bay with the exception of an area adjacent to the thermal discharge from Consumers Power Company Karn and Weadock Generating Stations. Tables 1 and 2 contain average and maximum water temperatures for Saginaw Bay measured at the Bay City Water Plant. From these data it can be seen that maximum summer temperatures occur during the months of July and August, whereas winter minima are observed during December, January and February.

2.14 Water Quality. The State of Michigan water quality standards for Saginaw River and Saginaw Bay reveal that the Saginaw River from its confluence with the Tittabawassee River to the Saginaw River's mouth is not protected for either Domestic Water Supply, Industrial Water Supply nor Total Body Contact. The Saginaw River is, however, protected for Tolerant Fish, Warm Water Species. In general, waters protected for Tolerant Fish, Warm Water Species, will also be protected for Partial Body Contact and Commercial use.

2.15 Referencing State of Michigan water quality standards for Lake Huron, designated use areas, the water quality standards for the designated use areas shall not apply during periods of authorized dredging for navigation purposes and during such periods of time when the after-effects of dredging degrade water quality in areas affected by dredging.

2.16 Where the waters of Lake Huron are classified under more than one designated water use, it is intended that the most restrictive individual standard of the designated water uses shall be adhered to.

2.17 In areas adjacent to outfalls, the standards for the designated water use or uses shall apply after admixture of waste effluents with the public waters but in no instance shall the mixing zone act as a barrier to fish migration or interfere unreasonably with the designated water use or uses for the area. The Water Resources Commission must have discretion in determining the extent of the mixing zone. In general, the Water Resources Commission encourages the use of outfall structures which minimize the extent of the mixing zone.

2.18 Based on their existing uses and reasonable future uses the waters of Lake Huron were classified into designated use areas as described below. Also see Appendix B.

a. All waters of Lake Huron will be protected for Water Supply -- Domestic. The individual parameters shall be measured at the point of water withdrawal.

b. All waters of Lake Huron will be protected for Water Supply -- Industrial. The individual parameters shall be measured at the point of water withdrawal.

c. All waters of Lake Huron shall be protected for Recreation -- total body contact, except in the immediate vicinity of enclosed harbor areas where partial body contact shall apply.

d. All waters of Lake Huron will be protected for Fish, Wildlife and Other Aquatic Life -- intolerant fish -- cold water species that are naturally suitable for such use.

e. All waters of Lake Huron will be protected for Fish, Wildlife and Other Aquatic Life -- intolerant fish-warm water species.

f. All waters of Lake Huron will be protected for Agricultural Use.

g. All waters of Lake Huron will be protected for Commercial Use.

2.19 The Saginaw River is a slow-moving stream having only a 2-foot drop in its total length of 22 miles. The depth, velocity, and discharge of the river are strongly affected by the height of water in Saginaw Bay. A sustained southwest wind lowers the level of the bay and temporarily increases river velocity and discharge. A sustained northeast wind causes the opposite result. At times, the flow of the river reverses.

2.20 Water quality in the area of the proposed dredging and referenced disposal facility is largely determined by the flow of the Saginaw River. When winds blow from the northeast down Saginaw Bay the water quality at the Channel-Shelter Islands is relatively free of pollutants reflecting the quality of Lake Huron. When the wind is west to southwest water from the Saginaw River is transported to the Islands area.

2.21 The water quality of Saginaw Bay reflects the abundance of waste materials received from the Saginaw River and other small rivers tributary to the Bay. The existing water quality is adequate to support all designated uses with minor exceptions. The waters of the inner bay are considered substandard with respect to nutrients and coliform bacteria. Sufficient nutrient levels exist to support algal blooms and extensive algal blooms have occurred.

2.22 Schelske and Roth in their 1970 study of Lake Huron including Saginaw Bay, divided the local area into four zones (Figure 4). Dissolved chemical constituents were lowest in Zone I (essentially uninfluenced by Saginaw River water), slightly higher in Zone II (perhaps occasionally influenced by the river water), highest in Saginaw Bay proper, Zone III (where the Saginaw River has a major influence), and second-highest in Zone IV (where inputs from Saginaw Bay increase concentrations of dissolved substances relative to the more northerly zones). Table 3 indicates the zonal differences of selected environmental factors observed during that study (Schelske and Roth, 1973).

2.23 Water quality along the western shore of Saginaw Bay, north of Bay City may be considered substandard because of high coliform levels at beaches which exist along this portion of the Bay.

2.24 Although many industrial plants along the river have achieved a very high degree of wastewater treatment, outflowing wastes from the river continue to have a severe impact on the quality of the receiving waters. The waters of Saginaw Bay differ from those of the main body of Lake Huron in several respects: higher concentrations of calcium, sodium and potassium, chlorides and sulfates; greater degree of hardness; higher temperatures and more turbidity. Data collected by Dow Chemical at the mouth of the Saginaw River in 1971 show high concentrations of metals in the suspended solids collected over a period of three months in test tubes suspended in the water column.

2.25 The Saginaw River is the main source of water constituents to Saginaw Bay and the principal influence on water quality in the Bay. Five wastewater treatment plants use surface waters of the Saginaw River for wastewater treatment. Four - Essexville, Zilwaukee, Bay City and Buena Vista Township - have new secondary treatment plants with phosphate removal, and the City of Saginaw anticipates completion of a similarly updated plant within a year.

2.26 The Bay Metropolitan Water Supply System has a 48-inch water intake located approximately four miles northwest of the proposed disposal site. The construction of the disposal facility and its localized disruption of the pattern of current flow should have little effect on water quality at the intake. The Saginaw-Midland Water Supply system intake is located some seven miles north of the present open water disposal site.

Ecology

2.27 Saginaw Bay contains most of the 29% marshlands of the Lake Huron shoreline. Approximately 40,500 acres of marsh provide a feather-edge shoreline on a gently sloping 700-1 gradient landward to agriculture lands. These lake plain, saturated-soil marsh lands may extend inland one mile. The distance from moist soil edge to a 6-inch depth of water ranges up to 3,000 feet, approximating a 6000-1 gradient.

2.28 Recognizing the high wildlife value, the Michigan Department of Natural Resources has acquired seven wildlife areas around the bay for public fishing and hunting: Quanicassee, Nayanquing, Tobico, Fish Point, Wigwam Bay, Wildfowl Bay and Crow Island.

2.29 Fish Resources* (**) - Ninety species of fish have been recorded for the Bay area. Among the important species are smelt, white sucker, channel catfish, yellow perch, walleye, whitefish, bullheads, rock bass, carp, alewife, smallmouth bass, northern pike, rainbow trout, and coho salmon. Numerous forage and non-commercial fish represent the remaining species.

2.30 Commercial fishing became an established industry in the mid-1800's as the expanding population created a demand for fishery products. The commercial fishery during the period of 1879 to 1930 paralleled development of the fishery in the other Great Lakes. Production rose steadily between the mid-1800's and the turn of the century reaching a peak of 20 million pounds for Lake Huron in 1902. Lake Huron ranked third in commercial fishery landings during these years, behind Lakes Erie and Michigan.

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*National Estuary Study, Vol. 3, U. S. Department of the Interior, Fish and Wildlife Service, January 1970.

**See Appendix F for scientific names.

2.31 The history of the total commercial production in Saginaw Bay has been one of a gradual buildup to a peak followed by a progressive decline to the low level of output in recent years. This decline in Lake Huron and Saginaw Bay is closely associated with the dramatic decline of the lake trout, whitefish, lake herring, chubs, and yellow perch. Table 5 lists the commercial fishing success in Saginaw Bay over the period 1960-1971.

2.32 Saginaw Bay's fish community has been heavily altered, particularly in the last half century. Species composition has changed dramatically to low value fish, and fish production has steadily decreased to its present low. Lake trout, walleye, whitefish, and lake herring once represented the bay's major resources; today they are scarce. Carp and yellow perch now compose the majority of the catch. Causes for these changes include changes in the foodweb, predation and competition from invading marine sea lamprey and alewives, changes in habitat, commercial fishing exploitation, and changes in water quality.

2.33 Lake trout had all but disappeared by the mid-forties; whitefish has been scarce and produced only in small quantities since the mid-thirties; walleye abundance has been low and production has not exceeded 100,000 pounds since 1948. Of the remaining principal species chubs and herring have been depleted, walleye may no longer be taken commercially, whitefish only by permit from the Department of Natural Resources, perch populations may be overharvested.

2.34 Intensive programs have been underway to control the lamprey, to improve methods of operations and to introduce high-value predatory species. Coho and chinook salmon, rainbow, brown and lake trout have been stocked in large numbers in Lake Huron. Meanwhile the ecological balance has been disrupted and dominance has changed from high-value to low-value species.

2.35 In 1967, the Michigan catch for Lake Huron was about 3,200,000 pounds (one million pounds carp) as compared to the 1902 peak production of 20 million pounds.

2.36 Saginaw Bay supports an active, diverse, and year-round warm water sport fishery. The Bay traditionally has been a productive area for yellow perch and the shallow, weedy portions produce northern pike, catfish, largemouth bass, smallmouth bass, panfish and carp.

2.37 Yellow perch is probably the most important sport game fish in the outer areas of the Bay. Boat fishing and wading for smallmouth bass are popular. Several communities conduct bass and perch fishing festivals. Bass fishing occurs in the shallow marshy areas adjacent to the shoreline and along the gravel bars and reefs adjacent to the islands and spits of land extending into the bay. Perch fishing is concentrated near the shorelines, the bulk of the fishing occurring in less than 10 feet of water in areas not impacted by dredging or disposal.

2.38 In 1972 and 1973 the U. S. Fish and Wildlife Service Great Lakes Fishery Laboratory collected 18 species in and along the ship channel within a mile from the mouth of the Saginaw River. Alewife and carp were the dominant species captured in June, when spawning runs were beginning or underway for both species. Numerous carp were observed spawning near Channel and Shelter Islands immediately east and north of the site. Alewife, carp, spottail shiner, gizzard shad, and yellow perch made up 97 percent of the total numbers caught. Eleven other species accounted for the remainder. Yellow perch were the most abundant sport species in the area (7 percent of the total catch). Principal species and numbers of fish captured near the mouth of the Saginaw River during 1972 and 1973 are as follows:

Species	Total Number	Percentage of Total
Alewife	1,679	67
Carp	153	6
Gizzard Shad	62	2
Spottail Shiner	352	14
Yellow Perch	186	7

2.39 Fish collections were made by Consumers Power Company in 1972 to determine populations in and around the Karn and Weadock plants. In the discharge channel and eastward, seasonal catches yielded dominant numbers of carp, shad, perch, shiners, and alewife. The results of several trawls are reported in Table 6. The location of the trawl surveys are found in Figure 5.

2.40 In the fall of 1967, adult coho salmon were planted in the AuGres River and in the spring of 1968 smolts were planted in the Tawas River. The Michigan Department of Natural Resources, Fisheries Division, has stocked western Lake Huron annually since 1970 with brown and lake trout.

2.41 The network of streams, lakes, and impoundments in the major watersheds of the basin provides excellent boat and bank fishing where public access is available and where shoreline conditions are suitable. Very little bank fishing is done around the bay in this area due to low marshy shorelines and shallow water offshore. Heavy runs of northern pike, suckers, and smelt move up the rivers during the spring. Some fishing for rainbow, brook, and brown trout is found in isolated reaches of streams and lakes emptying into the north part of Saginaw Bay. In addition to the above species, crappie, bluegill, rock bass, yellow perch, largemouth bass, and walleye are taken.

2.42 The activities of sport fishermen are not nearly as well documented as the Great Lakes commercial fishery functions. However,

as an example of the sport fishing pressure, it has been determined that a minimum of 240,000 anglers fish in the Lake Huron drainage for an angler-day usage of 4.8 million.

2.43 Ice fishing for panfish is an important aspect of the Michigan sport fishery in Saginaw Bay. In certain protected embayments, the ice fishing pressure almost equals that of open water fishing. Although the primary interest is catching panfish, "dark houses" are used to spear northern pike.

2.44 Waterfowl Resources**-The Bay is a nationally known waterfowl concentration area. Tremendous numbers of waterfowl are associated with the aquatic plants along the marshy shores. The species found belong to one of three general groups: geese and swans, diving ducks, and marsh birds such as coots and rails. The birds use the wildlife areas during fall and spring migration and for breeding in the summer. In summer major use is the marsh areas and uplands bordering the Bay. Very few waterfowl winter in Saginaw Bay. Open water is limited to the mouth of the Saginaw River and in the area of Consumers Power's effluent outfall. Although breeding birds utilize these areas, this is of secondary importance when compared to the use during the migration periods. Saginaw Bay is a link in the Chesapeake Bay migration corridor for diving ducks, with a split in route for dabbling ducks which enter both the Atlantic and Mississippi flyways.

2.45 It is estimated that at least 30 species of waterfowl and marsh birds are available to hunters from October to December. An average of 14,345 waterfowl hunters annually use the Bay area. The average annual hunter days involved was 106,234 during 1965-1974. Hunting is permitted on most of the following State game and wildlife areas in the coastal regions of the bay:

Tobico Marsh State Game Area	1,848 acres
Fish Point Wildlife Area	3,076 acres
Nayanquing Point Wildlife Area	1,146 acres
Quanicassee Bay Wildlife Area	218 acres
Wigwam Bay Wildlife Area	146 acres
Waterfowl Bay Wildlife Area	1,790 acres
Crow Island Wildlife Area	911 acres

2.46 Because of the abundance of these natural areas, Shelter-Channel Islands and surrounding open water are relatively unimportant for supporting waterfowl except gulls, which are the major users of this area.

2.47 The areas surrounding the proposed location provide habitat for numerous species of birds. Local habitats are conducive for birds adopted to marshlands and shallow and open water areas. Birds likely observed in such areas include diving ducks, dabbling ducks, gulls, wading birds, shorebirds, and numerous species of songbirds.

**See Appendix F for scientific names.

2.48 Although the wetlands are still productive wildlife areas, there has been a noticeable reduction in total numbers of various species. Human disturbance of marshlands has resulted in the decline of water dependent wildlife in the Saginaw Bay area.

2.49 The lowlands and marshes bordering Saginaw Bay support muskrat and mink in the wetter areas and raccoon, weasel, skunk, opossum and fox in the drier areas. Higher water levels since 1964 have favored muskrat production. Burrowing muskrats, however, have caused damage to dikes and retaining walls in the Saginaw Bay area and the tributary streams. This has resulted in costly and time consuming repairs on public and private properties. Extended trapping seasons during this period have increased the harvest and exercised a control on the population. Mink appear to be decreasing. This decline is evident in the harvest. The number of mink trappers have been fairly constant throughout the bay region, but the annual harvest has been steadily dropping since 1964 although the resource prevails. There are also lesser numbers of other fur species such as skunk, opossum, fox, raccoon and weasel, trapped in the Bay area. The Saginaw Bay drainage supports populations of cottontail rabbit, gray squirrel, fox squirrel, and white-tailed deer. These provide hunting opportunities for thousands of Michigan sportsmen.

2.50 Benthic Organisms - The bottom fauna of Saginaw Bay includes many species representative of most groups of aquatic life. Changing water quality and aquatic environmental conditions affect the indigenous populations. Twenty major groups have been identified in the entire bay. The most abundant forms were amphipods, oligochaetes, sphaeriid clams, tendipedids and nematodes. Oligochaetes were predominant in water depths less than 60 feet or most of the inner zone area. Amphipods dominate in those areas greater than 60 feet or in the outer zone and Lake Huron proper.

2.51 Oligochaeta, a biological indicator of enriched or polluted habitat, was most heavily concentrated at the mouth of the Saginaw River. This area was typified by an ooze bottom with strong sewage odors. No amphipods were found at the outlet of the Saginaw River, but increased in numbers lakeward in deepening waters. These more important benthic organisms are typical inhabitants of large, cold, deep non-polluted lakes. The presence of numerous macroinvertebrates along with extensive beds of aquatic vegetation provides a rich supply of foods for fish and wildlife.

2.52 An ecological survey made in Saginaw Bay by Dow Chemical in 1971 compared populations found in three areas of the Bay: north of the channel near the river mouth, two miles west and two miles east of the river mouth. Species diversity was found to be greatest in the western bay area, while all areas had a dominance of pollution-tolerant oligochaeta worms.

2.53 A study of benthic organisms is presently being undertaken by the U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife for the Corps of Engineers Navigation Season Extension Program in Saginaw Bay. The site of the project is about 1 mile northeast of the mouth of the Saginaw River. The area encompasses 3,000 feet of the channel and adjacent bay floor and is southwest of the proposed disposal site. The dredged channel is about 350 feet wide and 27 feet deep; the adjacent bay floor has an average depth of 9 feet (low water datum).

2.54 An interim report, covering a period from 1972 through 1973, identifies three principal taxonomic groups present, with large numbers of organisms: Oligochaeta, Chironomidae, and Ostracoda. Diversity of organisms varied from 2 to 17 per station, highest at stations in the center of the channel and lowest at stations on the bay floor adjacent to the channel. Results of the benthos sampling is included as Attachment No. C.

2.55 Changes in population density of Oligochaeta and Chironomidae followed a systematic pattern during the seasons. Ostracoda were too mobile to be considered reliable indicators. Oligochaeta population density was highest at stations nearest the river mouth as might be expected, and at the edge of the channel bottom. Maximum density occurred early in the year, then declined. In the bay floor, however, there was a marked reduction in population which then stabilized.

2.56 Chironomidae also exhibited a relatively consistent seasonal trend, were scarce in the area adjacent to the channel, and abundant in the center of the channel bottom. This pattern suggests migration from the bay floor into the channel during the fall, over-wintering, and migration.

2.57 Continued invertebrate sampling through all seasons of 1975 will provide additional data necessary to establish more definitive limits on "normal" population changes.

2.58 Phytoplankton - Because Saginaw (inner) Bay is relatively shallow and has a high flushing rate, nutrients are constantly being introduced from various sources and are circulated throughout the bay. Levels of these nutrients are sufficient to cause nuisance algal blooms. Study in progress in Saginaw Bay is designed to identify and to model the processes that occur within the bay, to predict the effects on the adjoining areas of Lake Huron. The initial phase involves physical, chemical, and biological programs, initiated in October 1973 and terminating in 1975. Additional data is being collected to confirm that the model actually predicts real conditions in Saginaw Bay. The study is being conducted cooperatively by the Michigan Water Resources Commission, the University of Michigan, the Dow Chemical Company, various municipal agencies, the Canadian Centre for Inland Waters, and the Environmental Protection Agency, with grants to the Cranbrook Institute and the University of Michigan.

2.59 Observations made of the sampling program describe the development of a phytoplankton kinetics model which is to be integrated with a model describing the hydrological circulation in the bay. Patterns in systems are developed which show the effect of various levels of the nutrients, phosphorus, nitrogen, and silica on four important classes of algae; a diatom, green alga, and two blue-green algae. Tentative conclusions, based on data-based simulations, are that drastic reductions in phosphorus loadings are necessary, with or without corresponding reductions in nitrogen, before any significant decrease in phytoplankton growth will occur in the bay. Even if all point source discharges of phosphorus to the watershed are eliminated, phosphorus input from non-point sources may still cause nuisance algae blooms.

Existing Saginaw River Dredge Disposal Site At Middle Ground Island, Saginaw River, Bay City, Michigan

2.60 Middle Ground Island, a slightly crescent-shaped island, is located between six and eight miles upstream of the mouth of the Saginaw River. The island is approximately 10,800 feet long; its widest point being approximately 900 feet wide at the center. The island is approximately 120 acres in size. Presently, with one exception, the island is relatively flat with an average elevation of 583.0 feet above mean sea level. The Saginaw River gage for the winter of 1975 was 576.8 feet, while for summer of 1975 the average river gage at the island was 579.3 feet.

2.61 Originally a low marshy area, the island has been used for years by the city of Bay City as a sanitary land fill. Over the years the Corps has filled in the north end of the island with dredged sand and silt. The central portion of the island has been filled in by the city of Bay City.

2.62 Referencing a general history of the island, the city of Bay City has dug 20 foot deep cells and used same for sanitary disposal until 1972. The filling served a dual purpose for the city in that, in addition to sanitary purposes, the filling tended to elevate marshy portions of the island. When the State of Michigan intervened to stop this activity, the city conceived a plan to build a ski hill on the island out of alternating refuse layers overlain with river dredgings. To accomplish the aforementioned, the city built a diked disposal facility in the central portion of the island along its western river boundary, approximately 1,500 feet south of Lafayette Street. The diked disposal facility was built on city property and is still owned, operated and maintained by Bay City.

2.63 The diked disposal containment facility encompasses an area of approximately 12.7 acres and is composed of two adjacent approximate equi-dimensional cells, each approximately 600 feet on a side. The cells are constructed of on-site earthen materials and are interconnected with an 18-inch diameter pipe and control valve. The design volume of the facility is 150,000 cubic yards. The dike sides are constructed

with 1 on 1 side slopes and the top of the dikes are eight feet across the top of the dike. The diked sides are ten feet high with a top elevation of 593.0 feet.

2.64 Presently the containment facility only receives approximately 140,000 cubic yards of polluted material dredged from the Saginaw River, from the Detroit and Mackinaw Railroad Bridge to the upper limits of the harbor. The dredge pumpout facility is located on the east side of the island opposite the containment facility. Presently, the city removes by truck approximately 100,000 cubic yards of material from the facility to a site located approximately 1/4 to 1/2 mile south of the disposal site. The trucked material is then used by the city to help construct a ski hill as previously indicated. To facilitate dredged material removal from the disposal facility, the use of the 2 cells in receiving dredged material is rotated. To accelerate drying, excess water is drained from the receiving cell to the adjacent cell. Two discharge weirs located on the west side of each cell allow for water discharge back to the river.

2.65 The estimated life of the Middle Ground diked containment disposal facility, as of this date, is three years -- the time estimated for the city to complete its construction activities on the aforementioned ski hill. The hill is being built under a Michigan Department of Natural Resources Permit. The hill is presently approximately 30 feet high, and has been, and will continue to be constructed of alternating layers of city refuse topped with dredged materials trucked to the site from the existing containment facility. To prevent surface runoff from either placed dredged materials or refuse, under Michigan DNR permit stipulation, the city will have to cap the ski hill with five feet of clay, seed and landscape.

2.66 The anticipated use of the hill for recreational skiing will be compatible with the surrounding terrain, ecology and present use of this part of the island.

2.67 Trees of varied size and height are located south of Cass Avenue across the street from the ski hill. Bird life has been observed to be primarily gulls.

2.68 Recreational usage would be compatible with the existing marina and bar located on the east side of the island and just south of the dredge pumpout facility. There presently exists approximately 20 residential homes on the south end of Middle Ground Island, to the south of Cass Avenue. A saw mill producing finished lumber and a marine contractor are also located on the island.

Proposed Saginaw River & Bay Dredge Disposal Project at Saginaw Bay, Michigan

2.69 The Final Environmental Impact Statement for the referenced proposed "Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan" was filed with CEQ on 29 May, 1975, and sent to the public and various interested agencies and officials on 11 June, 1975. Copies of same may be obtained from:

U. S. Army Engineer District, Detroit
150 Michigan Avenue
Detroit, Michigan 48226
Attn: Environmental Resources Branch

For clarity and ease of reference, the following eight paragraphs provide a description and discussion of the proposed disposal site that will be utilized in conjunction with "Maintenance Dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan." The referenced proposed disposal facility will be used to contain polluted sediments dredged from the Federal Navigation Channel in the Saginaw River and Saginaw Bay. At this time it is contemplated that the proposed island facility will be utilized in addition to and conjunction with the existing limited confined diked disposal facility located on Middle Ground Island, until such time that the Middle Ground Island disposal facility's expected life expectancy expires (approximately one year after completion of the proposed Channel-Shelter Islands facility). Middle Ground Island is located between six and eight miles upstream from the mouth of the Saginaw River. As previously indicated, sediments in the outer three mile reach of the Federal Navigation Channel are presently being analyzed for their pollutional status. If determined to be polluted, these materials, totaling a four-year backlog of approximately 43,000 cubic yards as of this date and a projected average annual volume of 11,000 cubic yards, will also be disposed of in the proposed confined disposal facility. If found to be non-polluted, they will be disposed of in designated open waters of Saginaw Bay, approximately 12-13 miles NNE of the mouth of the Saginaw River.

2.70 The proposed island site is located on the southeast side of the shipping channel approximately two miles from the mouth of the Saginaw River between channel stations 75+00 and 140+00. This is also the site of two existing islands, Channel and Shelter Islands formed from dredging and deepening of the adjoining shipping channel in the 1960's. The islands have not stabilized but have steadily eroded since this time, contributing to shoaling in the channel that is particularly heavy at this location. The islands consist of hard silt on which willows, grasses, reeds and rushes have become established. Large numbers of gulls use these islands for resting.

2.71 The proposed containment facility will encompass an area approximately 355 acres in size. This includes the two existing islands created by channel dredgings as well as the open water surrounding the islands. The shape of the new island will be irregular, though generally circular in order to create a more pleasing, natural landform for future use as a recreational area. The dike will have a top elevation of 14 feet above Low Water Datum (576.6 feet) and extend 14,000 feet around the perimeter of the island. The facility will have a capacity for 12 million cubic yards of dredged material, the estimated amount for 10 years of annual maintenance dredging and accumulated backlog.

2.72 According to preliminary designs for the project, the dike will be comprised of stone in various sizes. The basic outline of the dike is described as follows: The top elevation of the dike will be 14.0 feet above Low Water Datum, be 10 feet wide at the top and slope to the lake bottom at 2-1/2 horizontal on 1 vertical slope on the lakeside with 2 horizontal on 1 vertical on the inside; the outside of the dike exposed to the wave and ice forces from Saginaw Bay will be protected with armor stone and will be placed in various layers for a total of 9 feet of total thickness. The outer layer will be large stone; the layers underneath this will be made up of stone weighing approximately 10 per cent of the cover stone. An 18-inch thick layer of mattress stone will be placed at the toe of the dike section under the protective stone. Final designs will develop as project plans advance and after field work is accomplished to identify physical requirements related to the site. Dikes will be designed to prevent leakage of contaminated material, resist wave erosion, and prevent wave overtopping.

2.73 A discharge weir will be built into the dike to allow excess water to return to the bay. An oil skimmer will be installed in the weir. This is a manually operated device to trap oils and floating debris, which is then removed by maintenance crews. A design for sufficient settling time of dredged material within the diked area is intended to produce an effluent of acceptable quality. Monitoring of the effluent will be carried out by the Corps. The monitoring by the Corps will be conducted in accordance with approved procedures and EPA guidelines. Additional monitoring may be initiated as deemed necessary.

2.74 A turnout basin for the dredge will be constructed off the channel on the northeast side of the facility. A pipeline supported by trestles will carry the dredged material to the disposal area within the dike. By using a system of "y" and gate valves, the discharged sediment can be controlled to create a drainage system which provides maximum retention time for runoff and settling time for suspended sediments.

2.75 Construction of the facility will be accomplished by waterborne equipment, transported from convenient dockages. No on-site material will be used for the construction of the dike.

2.76 At the time dredging is resumed and operation of the facility begins, effluents from the weir will be sampled in order to determine water quality.

2.77 Following completion of the project after ten years, the island would be taken over by Bay County, having provided the necessary assurances to the Michigan Department of Natural Resources and to the Federal government as required by PL 91-611 prior to construction of the project. Present planning by the local governments is to create a unique recreational resource for the area on the island. At the present time, recreational use of the bay is largely provided by over 7,000 acres of State wildlife and game areas occupying extensive shallow, marshy shorelines around the bay.

2.78 The Congress, in directing the Secretary of the Army to confine polluted material, required the construction of such sites without regard to a strict calculation of the benefits of such sites relative to their costs, since they were envisioned as a temporary measure to relieve unacceptable environmental stress upon the water bodies subject to open lake disposal rather than as a permanent solution to the problem of disposal. Economic considerations are an important factor, however, in selection of a preferred site.

Threatened and Endangered Species

2.79 The 26 September 1975 Federal Register update lists two species of animals that are classified by the Department of the Interior as threatened or endangered and may live in the vicinity of the Federal channels. They are the longjaw cisco (Coregonus alpenae) and the Indiana bat (Myotis sodalis). The longjaw cisco is reported to occupy portions of Lakes Michigan, Huron and Erie. The fish normally inhabit the moderately deep waters of the lakes and spawning is reported to take place in deep water, in November. Maintenance dredging should have little effect on the species. The remaining species is terrestrial and maintenance operations in the water pose no threat to its existance.

Social and Economic Environments

2.80 The Bay City and Saginaw areas can be categorized primarily as industrial and blue-collar. Though adjacent to water (Saginaw Bay) the area has not developed as a recreational, tourist, or scenically residential locale; rather industries, especially utilities and petrochemicals, have capitalized on the water-borne transportation capabilities of the Bay with the resultant industrial character of the area. The population of the area has been steadily increasing and is projected to continue to increase as long as the industrial base does not weaken. The future of the Saginaw River and Bay as dependable transportation routes will, of course, impact on the industrial base and labor force. More specific descriptions of present and projected social conditions follow.

2.81 Population Growth - Both Bay and Saginaw Counties have experienced population increases; since 1960 the increases have been 10% and 15% respectively. However, these increases are in the rural and suburban Census tracts; city populations have actually decreased

8% and 6% respectively. The Planning Commission for Bay County has projected the population will continue to grow until 1995, when the population of that county will reach 164,819, an increase of 40% over the 1970 figure of 117,339 (Table 7). This increase will be felt only in the suburban tracts; Bay City's population will continue to decrease by as much as 11%. It is anticipated that Saginaw (city) will also experience a similar trend. A visit to downtown Saginaw demonstrates presently declining inner city, with vacant store fronts and buildings to be demolished. Downtown decay in Saginaw has prompted suburban shopping centers and development outward from the city. Since 1965, 12% of current suburban residents of Saginaw County have moved from the central city area to the suburbs; another 12% of the suburbanites moved to the area from outside the Standard Metropolitan Statistical Area since 1965.

2.82 Residential Characteristics - Residential property values are generally higher in the suburban tracts surrounding Bay City and Saginaw. The median value of residential properties in Bay County is $14,900. Only one city Census tract, located outside the downtown area to the west, has higher median values. Also, the Census tracts along the western side of Saginaw Bay (water frontage) have lower median values, even though in our culture access to water usually has resulted in higher relative property values. In Saginaw County, the median value of residential property is $16,300. But, again, the further away from the central city (and the Saginaw River), the higher the values. One could expect that in the future the trend towards more valuable and desirable suburban housing in the area of Michigan would continue with less value being attached to residence in either of these two central cities.

2.83 Recreational Characteristics - Popular recreational activities are boating and fishing although little objective information was available on this use of the bay area. Heavy use is made of the ship channels by all types of boats traveling between river dockages, the outer bay, and Lake Huron. Boat-watching is a form of shoreline recreation. A state park and state game area a few miles to the north provide a variety of activities, including a full-time naturalist program. Recreation is relatively undeveloped.

2.84 Natural and Scenic Characteristics - Few areas remain in this part of the bay which provide natural or scenic assets, other than those mentioned as recreational areas.

2.85 Water Uses - Industrial location reflects the availability of an economical water supply. Those industries which require large amounts of water for cooling or processing tend to locate near the Great Lakes. In Saginaw River Basin, with 11 industries reporting, there was a total consumption of 494,693.4 million gallons per year used by industry, 492,555.17 MGY of which was surface water. Consumers Power plants use approximately 412,000 and the Dow Chemical Company uses approximately 60,000 MGY of the total.

2.86 Educational Assets - Except for the state park, no other educational use of this area was identified. With the growing interest in natural areas, the demand for such outdoor educational laboratories will increase.

2.87 Traffic - Roads currently providing access to the proposed island disposal area are poorly maintained. If extensive development of this area is made, improvements to the roadways leading to the access site will probably be needed.

2.88 Community Cohesion and Interest Group Conflict - Residential groups in this area are identified by subdivision rather than by the larger community. However, it is not anticipated that the proposed project will impact on Community Cohesion.

2.89 Summary - Bay City, adjacent to a large water body, does have potential for recreational development and educational use of its water resources but to date, little planned development along the bay has been accomplished. Rather, industrial development has occurred.

Aesthetic Environments

2.90 Typical aesthetic environments range from major urban areas such as Bay City and Saginaw through residential subdivisions, extensive agricultural lands, and extensive Saginaw Bay frontage in a variety of land uses. For the aesthetic impact assessment it is appropriate to characterize the inner Saginaw Bay area only, the waters and the lands along the shoreline in the vicinity of the proposed project.

2.91 Land - The land surface is essentially flat with little or no natural relief. Because much of the shoreline is in marshes or temporary beach, there is little apparent erosion. The islands of the inner bay including Channel and Shelter, have a low and unstable profile with significant continuous erosion evident. The only noticeably elevated areas are the fill site occupied by the power plant at the mouth of the river, and a nearby breakwater approximately 8 feet high extending into the bay for a short distance. Protective riprap facing has been placed along the shoreline in several areas. There are no outcroppings of bedrock in the Bay City area. Bedrock approaches the surface near the entrance to the bay.

2.92 Water - Because of the shallowness of the inner bay, near shore waters are relatively placid except during storm conditions. Clarity of the water is limited by fine silt in suspension most of the time and by the common occurrence of algae in the water or attached to shoreline objects.

2.93 Air - Unpleasant odors are occasionally borne on southerly or southwesterly winds from industrial areas up-river or at the river mouth. However, pollution episodes are unusual and infrequent. Sounds are related to transient activities, from boats mostly. Natural sounds are pleasantly noticeable.

2.94 Biota - Vegetation is characterized by the low-lying shoreline and adjacent land, brushy and sparsely treed. The vegetation is dwarfed by large expanses of sky and water. An occasional row of willows contrasts with marsh plants and early successional plants on young soils. Gulls and, in season, large populations of migrating waterfowl are conspicuous.

2.95 Man-made Structures - Beachfront residences are relatively densely packed and located immediately on the shore. The power plant is grossly out of scale with the natural setting and is not landscaped or planted. Landscaping is unusual in the area. In the residential area, large specimen trees are visually dominant over scattered shrubbery.

2.96 Summary - The predominant aesthetic effect of the area is generally pleasing, dominated by the bay and marshy shoreline interspersed with man-made structures and developments.

Cultural Resources - Archaeology of the Area

2.97 Archaeological research of nearly a decade of excavation at the most productive ceramic sites known in Saginaw Valley concludes that there were no permanent agricultural villages in the valley, even during the favorable Neo-atlantic climatic episode. Interpretation of the sites excavated is that these were hunting camps, occupied seasonally by groups with both the Ottawa and Miami seasonal patterns. Following A.D. 1400, the valley appeared to have been almost empty up until the Chippewa settled in the area in the early eighteenth century after the establishment of the French post in Detroit.

2.98 The National Register of Historic places has been consulted and contact has been made with the Michigan State History Division. No National Register properties have been identified on the site. No known archaeological or historic sites have been identified in the area.

B. The Project Area

2.99 Because of the industrial nature of the Saginaw-Bay City Area, navigation channels through the bay and the river are essential to the maintenance of water-borne commerce. Total commercial tonnages for the years 1964-1974 are listed in Table 8. A breakdown of the commodities which contribute to the bulk of the water-borne commerce is also included (Table 8A, 8B). In 1974, a total of 1461 vessel passages were logged in and out of the Saginaw River. The draft of these vessels ranged from less than 12 feet to a maximum of 26 feet.

2.100 Sediment characteristics - As the result of tests conducted on Saginaw River and Saginaw Bay sediments in 1970 by the U.S. Environmental Protection Agency (EPA), bottom materials from the upstream limit of the project to 5 miles lakeward of the river mouth have been classed as polluted. Studies conducted in 1974 have extended the polluted sediment classification to a distance of 12 miles into the bay. According to EPA standards, the material is polluted because it exceeds the maximum values for volatile solids, COD, total Kjeldahl nitrogen, oil and grease and zinc. Sediment studies conducted in 1974 by the EPA in the Saginaw River and Saginaw Bay are included as Appendix A. Additional 1975 sediment analyses are included in Table 9. These data confirm the polluted status of sediments throughout the river and inner bay area. Sediments located in the outer 3 mile reach of the Federal Navigation Channel between 12 and 15 miles lakeward of the mouth of the Saginaw River are presently being analyzed for their pollutional status.

2.101 The bottom material to be removed is anticipated to be similar to that removed by prior dredging operations. Samples taken from the channel at river station 16 + 50 to deep water in Saginaw Bay indicate that shoal material consists of loose organic silts. From river station 16 + 50 upstream to 243 + 00, the shoal material consists of a mixture of organic silts, sandy clays, silty sands, clays and silty clays. Wood chips and shells are also present in this material. All of the shoal material consists of soft loose deposits lying above project depths previously established by new work operations. Sediment samples analyzed by Consumers Power Company in August 1973, contained 80 to 90 percent clay and silt. Organic content ranged from zero to nearly 97 percent. Field descriptions of the river and bay sediments are contained in Appendix A.

2.102 The shoals generally along the edges of the bay channel are believed to originate, for the most part, from the shallower lake bottom material on each side of the channel. Movement of the material is caused by wave action or propeller wash and to some degree by ice action. Heavy shoaling at the mouth of the Saginaw River, in part, results from the decreased velocity of the river as it enters the bay.

2.103 Water Quality - Water quality analyses were conducted on grab samples collected from Saginaw Bay and the Saginaw River in June, 1975. The results of these analyses, as reported in Table 10, show the river to be high in nutrient materials especially phosphate and nitrate. As the river water flows into the bay the effects of dilution are evident. Pollutant concentrations diminish with distance form the river mouth. Dissolved oxygen and temperature profiles at the various sampling stations were also taken during the 1975 field survey. The results are reported in Table 11.

2.104 Several water quality studies have been conducted on the Saginaw River and Saginaw Bay by the Dow Chemical Company, Consumers Power Company and the State of Michigan Water Resources Commission. The findings of these investigations and others provide a good deal of evidence as to the deteriorated water quality of the river and bay. Examples of some of the various water quality surveys are included as Appendix B.

2.105 Benthos - One of the most important ecological considerations relative to channel dredging operations is the benthic community. The bottom fauna of the Saginaw Bay are dominated by pollution tolerant forms. An ecological survey made in Saginaw Bay by Dow Chemical Company in 1971 compared populations found in three areas of the bay; north of the channel near the river mouth, two miles west and two miles east of the river mouth. Species diversity was found to be greatest in the western bay area; however, all areas had a dominance of pollution-tolerant oligochaete worms. According to Henson (1966), two characteristic (Great Lakes) oligotrophic profundal species, Pontoporeia affinis and Mysis relicta, are missing from the Saginaw Bay bottom fauna. These two organisms are also absent from other limited areas of the Great Lakes where water quality deviates from the norm.

2.106 A study of benthic organisms is presently being conducted by the U. S. Fish and Wildlife Service for the Corps of Engineers Navigation Extension Program in Saginaw Bay. The sampling site is about one mile northeast of the mouth of the Saginaw River and encompasses 3,000 feet of the channel and adjacent bay floor.

2.107 An interim report, covering a period from 1972 through 1973, identifies three principal taxonomic groups with large numbers of organisms. The principal groups include the Oligochaeta or aquatic earthworms, the Chironomidae or midges and Ostracoda or seed shrimps. Biological diversity at the various locations ranged from 2 to 17 taxonomic groups per station; highest at stations in the center of the channel and lowest at stations on the bay floor adjacent to the channel. Interim results of that study are included as Appendix C which also contains benthic data collected by the State of Michigan WRC and Consumers Power Company.

2.108 The results of benthos sampling conducted on June 14, 1975 are included as Table 12. These data confirm the presence of large numbers of pollution tolerant organisms and the low biological diversity common to the polluted bottom areas of the river and bay. Tubificid worms and Chironomid larva typify the benthic community.

History and Archaeology

2.109 The National Register of Historic Places has been reviewed and subsequent issues of the Federal Register checked. No National Register

properties nor archaeological or historic sites have been identified in the area that could be affected by the maintenance dredging operations. Correspondence has been received from the State of Michigan Historic Preservation Officer indicating that the proposed project will not affect any properties, either prehistoric or historic, which are listed on, nominated for, or eligible for the National Register of Historic Places (See Appendix E).

3. RELATIONSHIP OF THE ACTION TO LAND USE PLANS

3.01 The proposed maintenance dredging of the Saginaw Bay and Saginaw River Federal Navigation Channels will not alter, impede or adversely affect land use plans for the regional or immediate project areas. The disposal of polluted river bottom sediments will continue as in past years. The material dredged from the 17.5 miles upstream of the Penn Central Bridge will be placed in a diked disposal area on Middle Ground Island in the Saginaw River, provided by Bay City (Figure 1). The approximate annual volume of 140,000 cubic yards removed from that section of the river and placed on Middle Ground Island is periodically removed upon solidification and drying to the city's nearby sanitary landfill, for use in construction of the city's recreational ski hill. The city of Bay City is constructing the ski hill (sanitary landfill) under Michigan D.N.R. permit. The length of service of Middle Ground Island as a disposal site depends on both the quantity of materials deposited at the site and the amounts removed. Its anticipated life as of this date is 2 to 3 years.

3.02 Polluted river bottom materials downstream of the Penn Central Bridge to the river mouth and the bay channel to approximately 12 miles lakeward of the river mouth will also be place in a diked disposal area. A proposed project involves diking two previously created dredge disposal islands (Shelter and Channel) and creating a single disposal facility designed to properly contain the polluted materials (Figure 6). Although the projected use of the site is undecided at the present time, the following uses have been suggested: recreational, for boating, fishing, camping, nature trails, picnic grounds, playgrounds and museums; educational for an outdoor classroom; and commercial for possible industrial uses. Development of this island would have many problems some of which are supplying access, services and maintenance.

3.03 The project will add approximately 355 acres to existing county land while removing a like amount of bottom lands and public waters in the bay in excess of the area provided by Shelter - Channel Islands. This commitment of use is being made by the Michigan Department of Natural Resources as a compromise, having advantages for recreation,

for stabilizing erosion of existing disposal islands and for being relatively environmentally acceptable. The facility will be designed to accommodate disposal needs over a 10-year period commencing with initial use. The total volume to be contained over that period is currently estimated at approximately 12,000,000 cubic yards and includes accumulated back logs.

3.04 According to Raphael et. al. (1974), future maintenance dredging volumes in the Great Lakes are projected to increase only slightly, while new work volumes will decline. Where pollution elimination systems have been instituted, future maintenance dredging volumes and volumes of polluted dredgings may be lower than that of the past decade. Therefore, these projections, as applied to the Saginaw Navigation Channel maintenance dredging program, suggest that disposal needs will be similar beyond the 10-year designed capacity of the proposed Shelter-Channel facility. Future land use plans can be dealt with as subsequent sites are developed.

3.05 The materials dredged lakeward of the designated polluted area will be disposed of in the open water of Saginaw Bay (Figure 2). This procedure will have no effect on land use plans. The closest water supply intake structure is located four miles from the navigation channel.

3.06 The navigation channel predates most bridges crossing the river. These bridges are constructed with full consideration of the channel dimensions. Channel deepening projects are not undertaken without full soil and foundation investigations. No significant impacts on bridge foundations are anticipated by this work.

3.07 The Corps conducted two public meetings in March 1974 at Bay City, Michigan. These meetings were attended by planners, government representatives and the concerned public. The purpose of these meetings was to involve the public in the evaluation and selection of a disposal location which would be best suited to the public interest.

The proposed project was accepted by the Bay County Board of Commissioners unanimously on 12 November 1974. Although the projected use of the site is undecided at the present time, the following uses have been suggested: recreational, for boating, fishing, camping, nature trails, picnic grounds, playgrounds, and museums; educational, for an outdoor classroom; commercial, for possible industrial uses. Limiting factors are difficulties associated with supplying access, services, and maintenance.

4. THE PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT

A. Adverse Impacts

4.01 Since bottom sediments of the Saginaw River and the inner areas of the shipping channel in Saginaw Bay are classed as polluted by the U.S. EPA with respect to COD, volatile solids, total Kjeldahl nitrogen and zinc, it can be expected that some of these parameters will affect local water quality in the dredging area as the activity progresses. Additional local effects on other water quality parameters might also be expected during dredging operations. These parameters might include phosphorus, dissolved oxygen, turbidity, suspended and dissolved solids, organic materials and other nitrogen compounds. No harmful effects on water quality have been identified from open-lake disposal of unpolluted materials.

4.02 Temporary fluctuations in water quality should remain localized and create minor impacts in the channel area. Increases in turbidity due to hopper overflow and operation of the drags could be expected to discourage fish from frequenting the local dredging area during dredging operations and slightly reduce light penetration with insignificant effects on all forms of plant life. Local decreases in dissolved oxygen could be expected as oxygen-demanding materials are released from the bottom or are added with the hopper overflow from the dredge. Resuspended nutrient materials tied up in the sediments would have insignificant effects on the river or lake ecosystem.

4.03 The possibility of releasing trace metals from the disturbed sediments is very probable. Studies conducted on iron concentrations in Lake St. Clair by the Region V, EPA Michigan District Office, have shown dramatic increases in iron concentrations in turbid water created by overflow water from a Corps dredge (EPA, Region V, 1972).

4.04 If suitable sediment, wave and vessel speed exist, the hoppers may be economically filled without overflow.

4.05 Most of the bottom material throughout the length of the navigation channel is composed of silt and clay-sized particles; therefore, channel bottom disturbances and hopper overflow can be expected to redistribute some of the bottom material at the dredging site. Resultant settleable fines will layer the adjacent areas of the river and bay bottom and thus will temporarily disrupt the bottom-associated ecosystem of the areas involved. However, recovery should be rapid with minimal harm to benthic species and other bottom-associated organisms. For the most part, the benthos of the channel bottom areas to be dredged are pollution tolerant and adapt readily to such occurrences through prolific repopulation.

4.06 Disposal of sands and silts in open water can smother benthic organisms; however, surviving organisms and those located in adjacent areas (providing sediment characteristics are similar) will commence recolonization after the dredging activities cease.

4.07 Since the bottom sediments of the Saginaw River and from much of Saginaw Bay have been classed as polluted and dredged materials are destined to diked disposal, it is conceivable that most or all of the benthos and bottom-associated organisms removed from the channel bottom and transported to the diked disposal areas will be destroyed. However, the inherent ability of benthic species to repopulate a disturbed area and the ability of ecological systems, in general, to withstand temporary perturbations, ensures an enduring bottom-associated community.

4.08 Several minor outbreaks of duck poisoning (botulism) have occurred during the filling of diked disposal facilities. Anaerobic conditions conducive to the occurrence of botulism are recognized. It is possible to take remedial action should botulism occur on the site. This action is dependent on identifying those site conditions favorable to the causative bacteria. Such conditions include warm shallow water areas with little or no water circulation and the presence of food sources in the sediments, such as dead invertebrates, which support anaerobic organisms. These anaerobic bacteria, found everywhere, produce the toxin responsible for "duck sickness". Remedial actions may include flooding or drying the area.

4.09 Because of the limited width of the navigation channel in the Saginaw River and Saginaw Bay, it may be necessary at times for ships using the waterway to avoid meeting one another at the point where the hopper-dredge is working. This avoidance requires a right-of-way provision for one of the vessels which could result in speed checks and very short delays. The economic impact of such happenings is insignificant and these are considered routine procedures. The presence of the dredge in the navigation channel presents no unusual safety hazard to shipping. Minor diversions to the flow of pleasure craft might be created by the presence of the hopper-dredge in the channel or while unloading at the disposal facilities.

4.10 Although operation of the dredge is essentially silent, there will be some noise generated during dredging and unloading procedures. Excessive noise problems, however, are not expected to occur.

4.11 The fact that the polluted dredged material must be disposed of in a diked disposal area, determines that some ecological alterations will occur at the disposal sites. The Middle Ground Island disposal site serves as a temporary holding area for dredgings since the materials are subsequently removed to the Bay City sanitary landfill ski hill presently under construction to serve recreational pursuits. This procedure prevents the establishment of a stable ecological community at the Middle Ground location. The proposed Shelter-Channel Island

disposal site will undergo more permanent changes since it constitutes the final deposition site for dredged materials. Although little documented research data is available, dredge disposal sites commonly enter into an ecological succession pattern typical for climatic conditions of the given area. Revegetation occurs and associated animal species populate the site.

4.12 During construction of the disposal site, any fish spawning and rearing activities at Shelter-Channel Islands will temporarily be impaired. The resuspension of bottom sediments will generate a temporary increased turbidity condition and may decrease dissolved oxygen levels. These two conditions will indirectly impact the areas fish population by reducing phytoplankton as a food source, with a possible direct impact due to a potential depletion of the area's oxygen supply. These adverse effects will tend to cause fish to take-up habitats in surrounding undisturbed areas. Deposition of the resuspended sediments may also cause the loss of spawning beds that may exist in the immediate surrounding area of the project. Re-establishment of fish habitats will occur with the termination of project activities. The proposed diked disposal facility will provide 14,000 feet of potential habitat area for fish.

4.13 The rock face of the proposed diked disposal facility constitutes a stable substrate which could be colonized by filimentous algae such as Cladophora. This is a common nuisance, in such environments as provided by the shallow bay, when it becomes free floating and deteriorates. Although existing islands provide a certain amount of surface, this could be increased with the dike.

B. Beneficial Impacts

4.14 Annual dredging of the Saginaw River and Saginaw Bay navigation channel is an essential service necessitated by Congressional mandate and provided by the Corps to assure the maintenance of commerce throughout the Saginaw Waterway. During 1974, 4,180,075 tons of cargo passed through the Saginaw navigation channel. Without maintenance dredging, deep draft vessels would be forced to lighten loads or restrict passage through the channel, thus creating serious economic losses for shippers as well as maritime communities and the general public. Present high lake levels have made it possible to continue near-normal operation of the port since the last dredging operations of 1969 even though the authorized channel depth has been reduced as much as 4 feet in certain areas.

4.15 Shoaling occurs along the navigation channel as the result of wave action, propeller wash and sediment transport. As shoals build up in the channel, passing deep-draft ships create turbid water conditions as they pass over them; the result of bottom contact or propeller wash.

The effects of these intermittent disturbances on water quality include reduced light penetration and possible resuspension of pollutant materials from the channel bottom. These regular disturbances of the channel bottom are reduced or eliminated as the shoaled areas are removed.

4.16 The fact that Saginaw River and Saginaw Bay bottom sediments are polluted must be taken into account when measuring beneficial effects of the maintenance dredging program. The removal of pollutant materials from the river and bay bottom, coupled with the elimination of pollutant input sources through establishment of the National Pollutant Discharge Elimination System permit system, obviously will aid in the long-term cleanup of the system.

4.17 Construction of a contained disposal facility for polluted dredged materials from Saginaw Bay navigation channel, Bay County, Michigan, will create acres of upland in Saginaw Bay, replacing two small islands created by former dredging, and the surrounding bay bottomland and water. This is a commitment of a water resource to another use, loss of associated aquatic communities, and a change in the hydraulic regime. It is expected the prospective island landform will create minor changes in the latter and short-term losses in the former, with long-term reinstatement of comparable if not improved value: potential re-establishment of fish habitat in rock dike; upgrading of water quality in bay and Lake Huron through removal of considerable quantities of polluted bottom sediments; creation of a protected area in the bay to the lee of the island for present users of the area; elimination of continuing erosion from present spoil islands, a source of turbidity and channel shoaling; creation of a potential recreation area with resultant increased use of water resources of the bay for people and area wildlife. As indicated resumption of dredging will restore channel project depths and insure safe navigation without loss of shipping capacity which is of significant economic importance to the region and area.

4.18 The proposed maintenance dredging of the Saginaw River and Saginaw Bay Federal navigation channel will result indirectly in social and economic benefits to the area. Restoration of authorized project depths can decrease shipping cost through more effective utilization of the Great Lakes cargo fleet. Section 122 of Public Law 91-611 presents possible areas of impact that should be considered in relation to the proposed operations. These areas include, but are not limited to:

Noise	Regional Growth
Displacement of People	Business/Industrial Activity
Community Cohesion	Displacement of Farms
Community Growth	Man-Made Resources
Tax Revenues	Natural Resources
Property Values	Air Pollution
Public Facilities	Water Pollution

During the ongoing planning for the proposed maintenance operations,

these aspects were evaluated. The proposed action will have negligible effect on existing air quality and noise levels adjacent to the shorelines. The maintenance operations take place at distances of 1/2 mile and 2 miles (at the disposal sites) to 12 miles (dredging areas) from inhabited areas. The ambient noise levels adjacent the project area will persist within the present status spectrum. It is anticipated that the proposed activity will have little, if any, significant effects on patterns of living already established in the areas outlined above, except in the area of recreation. Present planning by the local governments is to create a unique recreational resource for the area on the proposed Shelter-Channel Island site following completion of the Corps project after 10 years. At the present time, recreational use of the bay is largely provided by over 7,000 acres of State wildlife and game areas occupying extensive shallow, marshy shorelines around the bay.

4.19 The National Register of Historic Places has been reviewed and subsequent issues of the Federal Register checked. No National Register properties nor archaeological or historic sites have been identified in the area that could be affected by the maintenance dredging operations. Correspondence has been received from the State of Michigan Historic Preservation Officer indicating that the proposed project will not affect any properties, either prehistoric or historic, which are listed on, nominated for, or eligible for the National Register of Historic Places (See Appendix E).

4.20 Following completion of the project after ten years, the island would be taken over by Bay County, having provided the necessary assurances to the Michigan Department of Natural Resources and to the Federal government as required by P.L. 91-611 prior to construction of the project. Present planning by the local governments is to create a unique recreational resource for the area on the proposed Shelter-Channel Island site following completion of the Corps project after 10 years. At the present time, recreational use of the bay is largely provided by over 7,000 acres of State wildlife and game areas occupying extensive shallow, marshy shorelines around the bay.

4.21 As previously mentioned, no National Register properties nor historic sites have been identified in the area that could be affected by the maintenance dredging or disposal operations. Correspondence has been received from the State of Michigan Historic Preservation Officer indicating that the proposed project will not affect any properties, either prehistoric or historic, which are listed on, nominated for, or eligible for the National Register of Historic Places (See Appendix E). It should be noted, however, that in response to the Corps' mandate for Recording and Preserving Historical and Archaeological Finds within its project areas, all items having any apparent historical or archaeological interest which are discovered in the course of any construction activities shall be carefully preserved. The archaeological find shall be left undisturbed and the proper authorities shall be notified.

C. Remedial and Mitigative Actions

4.22 Referencing the construction of the proposed Shelter-Channel Island disposal site to be used in conjunction with proposed maintenance dredging of polluted materials final designs will develop as project plans advance and after field work is accomplished to identify physical requirements related to the site. Dikes will be designed to prevent leakage of contaminated material, resist wave erosion, and prevent wave overtopping.

4.23 A discharge weir will be built into the dike to allow excess water to return to the bay. An oil skimmer will be installed in the weir. This is a manually operated device to trap oils and floating debris, which is then removed by maintenance crews. A design for sufficient settling time of dredged material within the diked area is intended to produce an effluent of acceptable quality.
Monitoring of the effluent will be carried out by the Corps. The monitoring by the Corps will be conducted in accordance with approved procedures and EPA guidelines. Additional monitoring may be initiated as deemed necessary.

4.24 A turnout basin for the dredge will be constructed off the channel on the northeast side of the facility. A pipeline supported by trestles will carry the dredged material to the disposal area within the dike. By using a system of "y" and gate valves, the discharged sediment can be controlled to create a drainage system which provides maximum retention time for runoff and settling time for suspended sediments.

4.25 At the time dredging is resumed and operation of the facility begins, effluents from the weir will be sampled in order to determine water quality.

4.26 Several minor outbreaks of duck poisoning (botulism) have occurred during the filling of similar disposal facilities. Anaerobic conditions conducive to the occurrence of botulism are recognized. It is possible to take remedial action should botulism occur on the site. This action is dependent on identifying those conditions favorable to the bacteria as they exist on the site. These conditions include warm shallow areas, with little or no water circulation, and the presence of food sources in the sediments, such as dead invertebrates, which support anaerobic organisms. These bacteria, found everywhere, produce the toxin responsible for "duck sickness" under anaerobic conditions. Remedial actions may include flooding or drying the area. The pipeline which will carry the dredged material into the dike has been designed using a system of "y" and gate valves. This will allow the discharged sediment to be controlled. This plan can help eliminate or control duck poisoning.

5. PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

5.01 The destruction or disturbance of benthic communities in the dredged areas is inevitable. There will also be some local disturbances to benthos in areas adjacent to the channel and, if the material in the outer 3 mile reach of the Federal Navigation Channel in Saginaw Bay is found to be non-polluted, in the open-water disposal area as dredging progresses. Physical removal of or addition to the bottom substrate and local increases in turbidity will be the causative factors of this unavoidable impact. Local increases in turbidity will also result in slight depressions of dissolved oxygen during dredging operations as oxidizable materials are released from the bottom sediments. Such dissolved oxygen depressions will be minimal and should not create ecological concern because of their localized and short lived nature.

5.02 Minor amounts of pollutants will be released from the sediments as dredging progresses. These releases are unavoidable; however, they will be countered by the benefits derived from the removal of greater amounts from the aquatic system in the dredged materials.

5.03 Disposal of the dredged material in diked areas will initiate changes in the local ecosystems of the disposal sites. These changes will be, for the most part, irreversible. During disposal operations, these areas may be aesthetically displeasing. Corrective actions include grading and seeding though natural succession of plants does occur within a year or two. In addition, protective measures such as rip-rap may be employed to reduce erosion of the dikes.

6. ALTERNATIVES TO THE PROPOSED ACTION

6.01 The proposed action involves the periodic maintenance dredging of the Saginaw River and Saginaw Bay, Michigan, Federal Navigation Channel by the U. S. Army Corps of Engineers as authorized by Congress. This involves the removal of the shoaling sediments and disposal of dredged materials into confined disposal facilities.

6.02 Alternatives to the proposed action can be separated as dredging alternatives or disposal alternatives.

A. Dredging Alternatives

6.03 Four alternatives can be considered under this category: 1) alternative dredge types, 2) discontinue maintenance dredging (no action), 3) dredge to a lesser depth, and 4) watershed management.

Alternative Dredge Types

6.04 Three alternative dredge types are utilized for maintenance depending upon the amount and type of material to be removed, the water depth, and conveyance to and method of disposal at the specific sites. The types are: a) pipeline-cutterhead, b) bucket or dipper and c) hopper.

6.05 These alternative types to the hopper dredge are practical and good in certain situations. Hydraulic pipeline dredges are economical and some contain cutting head attachments to allow removal of compacted sediments. A major disadvantage is possible pipeline interference with vessel movement. Pipeline lengths of 3,000 feet between pump stations are feasible. Long distance pumping is not without problems. Booster stations, pumps, power requirements and extra personnel add appreciably to the system cost. Contaminants leaking from the pipeline may result in temporary adverse impacts.

6.06 A bucket or dipper dredge is designed to lift sediments from the river bottom in a bucket and deposit the dredged material on a barge to be unloaded again by bucket dredge at the confined disposal site. Overall dimensions and capacity of bucket or dipper dredges vary. Selection is made to suit the operations for which they are required.

6.07 The main advantages include dredging capabilities in water areas too shallow for hopper dredges and in areas where no suitable land surface is available for conventional dragline operations. In addition, consolidated material may be removed from the navigation channel using this method. Disadvantages of the bucket or dipper dredges are: a) interference with waterborne vessel movement due to dredge and barge placement; b) less effective sediment removal than with hydraulic dredges due to dredge bucket digging rather than hydraulic dredge vacuuming; c) the turbidity is temporarily increased due to the disturbance caused by the dredge and the overflow from the barges; d) the disposal barge must dock and the sediment rehandled in order to unload the dredged material to the confined disposal site.

6.08 Strict cost comparion of different dredge removal operations can be misleading. Each type is best suited for a particular job. Location and amount of work, sediment type and disposal method affect costs. Based on 1969 data the least expensive dredge method was the hopper dredge. Hydraulic pipeline dredges were the next most economical and mechanical dredges were the most expensive.

Discontinue Maintenance Dredging (No Action)

6.09 The alternative of no maintenance dredging would result in a buildup of bottom sediments in the Saginaw River and Saginaw Bay Federal Navigation Channels. This buildup would necessitate a decrease

in vessel draft, thus diminishing the total tonnage of waterborne commerce common to the Saginaw System. The costs of waterborne transport would rise due to inefficient vessel use with increased costs passed on to governmental, industrial and domestic sectors of the economy.

6.10 Many vessels would be forced to eliminate the Saginaw System from their ports of call because of restricted draft. Other vessels that would continue operation would do so at a risk under adverse safety conditions. Polluted segments of the channel would contribute more substantially to deteriorating water quality as sediments were dispersed by continuing deep-draft vessel traffic.

Dredging to a Lesser Depth

6.11 Dredging to a Lesser Depth - Maintaining the navigation channel at a shallower depth would not be in the public interest. Implementation of this alternative would incur consequences similar to those of no action. Any depth less than that already authorized would restrict the load-carrying capabilities of commercial vessels and not represent optimum usage of the Great Lakes fleet. This reduction in efficiency would increase costs of commodities transported and would ultimately be reflected in increased product costs.

Watershed Management

6.12 Pollution abatement and land management for erosion control could reduce the need for dredging operations significantly. Studies are underway to determine the cost of land retention of sediments. Many governmental units are involved with watershed erosion control. Some are the U. S. Army Corps of Engineers' Waterways Experiment Station, U. S. Geological Survey, State Conservation Agencies, Soil Conservation Districts, Co-operative Extension Agents and land planning units of Universities.

B. Disposal Alternatives

6.13 Three alternatives are discussed as possible alternatives to the proposed plan for disposal: 1) all material disposed in open water; 2) upland disposal; and 3) pretreatment of material.

6.14 In terms of economics, practicality, irretrievable resources, and minimal ecological disruption, the process of confined dike disposal for polluted and unpolluted sediments offers the best solution at the present time.

All Open Water

6.15 Open water disposal of the dredgings from the Saginaw River and Saginaw Bay was not considered a viable alternative because all but

a very small amount of the sediments to be dredged have been classified as polluted, and therefore will be disposed of according to the guidelines developed by the Regional Administrator of the U.S. Environmental Protection Agency (33 USCFR 209.145(c)). Open water disposal of polluted materials in Michigan waters would also be contrary to the expressed desires of the Governor of Michigan to cease such practices.

Upland Disposal

6.16 Upland disposal requires an inland discharge area and pipeline or other means of conveyance. Inland disposal sites are relatively scarce, normally privately owned, and being used for solid waste disposal. It is a Corps policy to secure the maximum practicable benefits through the utilization of materials dredged from authorized navigation channels and harbors, provided extra cost to the Government is not incurred. Access to disposal pumpout facilities or near shore areas would normally require an access channel and turn-around area for the hopper dredges or other marine units. Utilization of marsh areas for sediment disposal is ecologically unwise and the process of long distance piping has economical, engineering, and logistical drawbacks.

Pretreatment

6.17 Treatment of dredge material could be accomplished in several ways: (1) local sewage treatment works; (2) separate onshore treatment plant; and (3) on-board treatment prior to in-lake discharge.

6.18 Assume the removal of a moderate amount of dredging, i.e., 1,000 cubic yards of material per day. An 0.5 percent slurry of that amount would be a volume equivalent to the wastewater discharge of 0.25 million people. Existing sewage treatment plants may or may not have the capacity to treat these additional volumes. Costs for new treatment plants are prohibitive and chemical treatment to settle the suspended solids is expensive. In addition, chemical floculation in conjunction with open lake disposal could cover lake bottoms with sediments unsuitable for biological production.

C. Alternate Sites for the New CDF

6.19 As previously indicated, a study was conducted to determine the best site for a new confined disposal site to be utilized once the present Middle Ground Island site is filled to capacity. Alternative sites considered were:

1. Gull Island Plan
2. Nayanquing Barrier Dike
3. Hampton Township Plan
4. Inland Sites
5. Upland industrial site
6. No action

Additional details on these alternatives may be found in Section VI of the FEIS, "Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan". As previously indicated, copies of the referenced FEIS may be obtained from:

U.S. Army Engineer District, Detroit
150 Michigan Ave.
Detroit, MI 48226

7. RELATIONSHIPS BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

7.01 Annual maintenance dredging of the Saginaw River and Saginaw Bay navigation channels allows waterborne commerce to continue between the Saginaw and Bay City Ports and other ports in the Great Lakes - St. Lawrence System. The continuance of shipping within this system expresses both short-term immediate needs such as maximum draft and long-term needs such as continued assurance of access between the Saginaw Port System and connecting areas of the Great Lakes. Existing project dredging has been carried out in the Saginaw System since 1910 although channel maintenance has been carried out since the 1880's. Curtailment would create serious repercussions to the immediate and long range economic and cultural development of these and other Great Lakes Ports.

7.02 Maintenance dredging will affect localized areas of the channel only temporarily resulting in a short-term disruption of the bottom-associated biological community. Similar disruptions will occur on bottom areas in the designated open-water disposal area. Reestablishment of these communities is expected to occur in a short period after dredging operations cease as the result of the inherent ability of ecological systems to withstand disturbances.

7.03 The fact that the bottom sediments of the Saginaw River and inner Saginaw Bay are polluted and recent action has been taken to provide diked disposal sites for the spoil, indicates concern for short-term uses of man's environment through the elimination of open water dumping and provisions for enhancement of long-term productivity by completely removing the material from the aquatic system.

7.04 Disposal of the dredge spoil in diked areas will initiate changes in local ecosystems of the disposal sites which will be, for the most part, irreversible and constitute long-term effects. Aesthetic impairment of the local areas of the disposal sites will occur and continue throughout the life of each site. However, long-term uses of the disposal sites as natural or recreation areas will compensate initial aesthetic impairments.

8. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED IF THE PROPOSED ACTION SHOULD BE IMPLEMENTED

8.01 Maintenance dredging of the Saginaw River and Saginaw Bay Federal Navigation Channels is expected to remove an annual average of 840,000 cubic yards of material. The dredging will irreversibly remove polluted bottom sediments and benthic organisms from the channel dredge areas and a given number of these biological components of the Saginaw River - Saginaw Bay ecosystem will be destroyed. The inherent ability of ecological systems to adapt to occurrences, however, assures that affected areas of the bottom will return to their original status once the dredging is completed if sufficient recovery time is provided before the next scheduled dredging. In the case of the Saginaw River maintenance dredging, the benthos may never reach a climax condition due to the disruption of the sediments by recurrent dredging operations.

8.02 The irretrievable use of resources for the proposed action include the commitment of manpower, money, petroleum-based fuels and vessels. The petroleum-based fuels to be utilized in the dredging of the proposed action constitute an irreversible commitment of limited hydrocarbon resources. Likewise, the manpower, money and use of (a) vessel(s) for the project will be irretrievable. Maintenance dredging will periodically alter the bottom environment of existing navigation channels and open water disposal sites as well as the developing ecosystems of the confined disposal sites. These processes are not considered irreversible as cessation of maintenance dredging would result in an eventual return of existing navigation channels to their natural conditions and would allow disposal sites to ecologically unify with their surroundings through successional characteristics of the climatic conditions of the general area. The fact that maintenance dredging is a reoccurring item provides proof that the conditions being altered will again establish at a later time. If no maintenance dredging occurred, the river would shoal at its mouth and eventually create a delta system. Maintenance dredging removes much of the material available for this delta formation and does not allow the river and entrance channel to completely fill with sediments.

8.03 Disposal of the polluted material into the diked island is considered an irreversible and irretrievable use. Drying and aerobic breakdown of organic matter will permanently alter this material. The disposal sediments are not in short supply and represent no major natural resources in their present form. Development of the diked disposal area would create a positive use of an irreversible action.

8.04 Discharge of polluted sediments to diked disposal areas involve possible contamination of the site. Certain plants are capable of

concentrating some heavy metals in their tissues in amounts greatly exceeding ambient levels. These concentrations may move up the food chain and ultimately affect man if he ingests contaminated food.

9. COORDINATION AND COMMENT AND RESPONSE

A. Public Participation

9.01 In prior years no public meetings, hearings, or workshops were held concerning maintenance dredging and disposal operations. This was based on the fact that the harbors and navigation channels were established as the result of Congressional legislation and the maintenance thereof was inherent in the Federal jurisdiction over navigable waterways.

9.02 The current practice is to issue a Public Notice of the intent to perform maintenance dredging in the specified Federal Navigation Channels and/or harbors. This maintenance work is reviewed under the following laws: Federal Water Pollution Control Act of 1972, the National Environmental Policy Act of 1969, the Fish & Wildlife Act of 1956, the Fish and Wildlife Coordination Act of 1958, the Marine Protection Research and Sanctuaries Act of 1972, the National Historic Preservation Act of 1966, the Endangered Species Act of 1973, as well as the various Congressional Acts authorizing construction and maintenance of the Federal project.

9.03 Any person who has an interest which may be affected by the disposal of this dredged material may request a public hearing. The request must be submitted in writing to the District Engineer within thirty (30) days of the date of this notice and must clearly set forth the interest which may be affected and the manner in which the interest may be affected by this activity.

9.04 Two workshops were conducted in March 1974 at Bay City. These meetings were attended by planners, technicians, natural resource managers, environmentalists, government representatives, and the general public. The purpose of the meetings was to provide and obtain information relative to the alternate sites being proposed. At this time the three feasible sites were Navanquing Point Wildlife Area (a barrier dike), Gull Island Plan (an island offshore west of the channel), and Shelter-Channel Island (a recreational island).

9.05 Citizens were in unanimous opposition to the Gull Island Plan, located offshore in the vicinity of a residential area. Professional participants found disadvantages in the Wildlife area barrier dike plan because of the 9 mile long approach channel needed in the bay for the dredge boat. A majority approved the Shelter-Channel Islands site, but the commitment to this use of bottomlands and problems of a well defined use for this site (without land-based access) were problems needing answers.

9.06 As a result of the workshops and continued coordination, alternate sites increased to seven (four additional) with various configurations of the new sites.

9.07 Site selection was further finalized through the cooperation of the members of a special ad hoc committee established by the Governor of Michigan. Members of this committee include representatives of the Governor, Michigan Department of Natural Resources, Bay County Commissioners, Port of Bay County and the Corps of Engineers.

9.08 A series of meetings were arranged with the site selection committee, with managers from various concerned agencies and governments, and with local people needing information. The Bay County Board of Commissioners and port director took an aggressive part in the negotiations which ensued to find a viable site. A meeting with the governor of the state was requested by the local committee for assistance in arriving at a decision. Col. James E. Hays, Detroit District Engineer, attended this meeting at Bay City and alternate sites were discussed and inspected. With the assistance of environmental experts on his staff, a decision was reached at a later date in favor of Shelter-Channel Island site.

9.09 Much professional consideration has been given the selection of the optimum site for the proposed facility. Clearly, this issue is controversial, and the proposed site a compromise decision, arrived at through a process of thorough investigation and purposeful communication between concerned parties on many community and governmental levels.

9.10 A Public Notice dated 12 February 1975 regarding annual maintenance dredging of the Federal navigation channels in Saginaw River, Michigan in 1975 and subsequent years was issued by the Corps' Detroit District Office. Copies of this notice were sent to the Environmental Protection Agency, the Department of the Interior, the U.S. Coast Guard, the State of Michigan, the Department of Commerce, Saginaw County, Bay County, the City of Essexville, and other Federal, State and Local agencies, as well as to known interested groups and individuals. Responses to this notice were received from the Department of Commerce, the Department of the Interior, the U.S. Coast Guard, the State of Michigan Department of Natural Resources and the U.S. EPA, and are contained in Appendix D. The EPA pointed out that sediments in the outer harbor, from EPA Survey Station SB7 (channel markers RN6 and BC5) to about 12 miles lakeward of the river mouth, are also classified as polluted. Therefore, the material to be dredged by this project is considered polluted and should be placed in a confined disposal facility. Open lake disposal of this material would not be consistent with their program to improve the water quality of Saginaw Bay. The replies from the other governmental agencies raised no issue with the proposed maintenance dredging.

9.11 Considering the lack of objection and in accordance with 33 CFR 209.410 and the pertinent laws and procedures on which these regulations are based, a Statement of Findings was issued on 12 June 1975 wherein it was stated that it considered in the public interest to continue maintenance dredging of the river channel and disposal on Middle Ground Island concurrent with the preparation of an Environmental Impact Statement and the construction of a new disposal facility. It was also determined that the lack of objection to the Public Notice obviated the need to hold a public hearing at that time.

B. Government and Other Assistance

9.12 The following governmental and other agencies have been contacted during the preparation of this Environmental Statement:

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Ocean Survey
Water Levels Branch
Lake Survey Center
Detroit, Michigan

Consumers Power Company
Environmental Department
Jackson, Michigan

Dow Chemical Company
Midland Division
Waste Control Department
Midland, Michigan

U.S. Environmental Protection Agency
Region V
Chicago, Illinois

Great Lakes Research Division
Institute of Science and Technology
Ann Arbor, Michigan

C. Proposed Statement Deliveries

9.13 Agencies and Officials - Copies of the Draft Environmental Impact Statement were sent to the United States Senators and Representatives, the State Governor, concerned Federal and State Agencies, and local governments, interested private organizations, and concerned citizens. The draft statement was also mailed in response to all requests. The addresses of the requesting citizens or agencies were noted and these interested parties will also receive a copy of the Final Environmental Statement.

9.14 The Draft and this Final Environmental Statement have been sent to the following agencies or officials:

Advisory Council on Historic Preservation
Federal Power Commission
Great Lakes Area National Park Service
Great Lakes Basin Commission
Michigan Area Council of Governments
Michigan Department of Commerce
Michigan Department of Natural Resources
Michigan Department of Public Health
Michigan Department of State Highways
Michigan Historical Commission
  -Office of the Planning Coordinator
National Marine Fisheries
State of Michigan, State Archeologist
State of Michigan, State Historic Preservation Officer
U.S. Department of Agriculture
  -Forest Service
  -Soil Conservation Service
U.S. Department of Commerce
  -National Marine Fisheries Service
  -National Oceanic & Atmospheric Administration
U.S. Department of Health, Education & Welfare
U.S. Department of Housing & Urban Development
U.S. Department of the Interior
  -Bureau of Outdoor Recreation
  -Bureau of Sport Fisheries and Wildlife
  -U.S. Geological Survey
U.S. Department of the Interior (National Park Service for Investigations of Historical, Archeological and Paleontological Resources)
U.S. Department of Transportation
  -Federal Highway
  -U.S. Coast Guard
U.S. Environmental Protection Agency
Water Resources Council

9.15 Citizen Groups - The Draft and Final Environmental Statement have also been sent to the following groups:

Advisory Council for Environmental Quality
Muskegon Chamber of Commerce
Lake Michigan Federation
Michigan Audubon Society
Michigan Parks Association
Michigan Unified Conservation Clubs
National Resources Defense Council

Sierra Club, Huron Valley Group
Sierra Club, Midwest Representative
West Michigan Environmental Actions Council
West Michigan Shoreline Protection Association

9.16 The following comment/response section addresses pertinent comments and suggestions submitted by interested agencies, groups, and citizens. In total, 10 replies to the Draft Environmental Statement were received.

Federal Agencies

Advisory Council on Historic Preservation
United States Department of Agriculture - Forest Service
United States Department of Agriculture - Soil Conservation Service
United States Environmental Protection Agency - Region V
United States Department of the Interior - Office of the Secretary - North Central Region
United States Department of Transportation - Federal Highway Administration - Region 5

State of Michigan

Department of Natural Resource
Department of State Highways and Transportation
Department of State - Director, Michigan History Division and State Historic Preservation Officer

Others

Saginaw-Midland Water Supply System

Federal Agencies

Advisory Council on Historic Preservation - Washington D.C.

1. Comment:

Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969; the National Historic Preservation Act of 1966; Executive Order 11593 of May 13, 1971; and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800) the Advisory Council on Historic Preservation has determined that your draft environmental statement is inadequate regarding our area of expertise as it does not contain sufficient information to enable the Council to comment substantively. Please furnish additional data indicating that the most recent listing of the National Register of Historic Places has been consulted and if any National Register Property

is affected by the project. A section detailing this determination must appear in the environmental statement.

Response:

No National Register property is affected by the proposed maintenance dredging operations in the Saginaw River and Bay. Section 2, paragraph 2, Final EIS, reflects this statement.

2. Comment:

If a National Register property is affected by the project, the environmental statement must contain an account of steps taken in compliance with Section 106 and a comprehensive discussion of the contemplated effects on the National Register property. (Procedures for compliance with Section 106 are detailed in the Federal Register of January 25, 1974, pp. 3366-3370).

Response:

See Comment/Response #1 above.

3. Comment:

Compliance with Executive Order 11593 of May 13, 1971 should be demonstrated. In the case of land under the control of jurisdiction of the Federal Government, a statement should be made as to whether or not the proposed undertaking will result in the transfer, sale, demolition, or substantial alteration of potential National Register properties. If such is the case, the nature of the effect should be clearly indicated.

In the case of lands not under the control or jurisdiction of the Federal Government, a statement should be made as to whether or not the proposed undertaking will contribute to the preservation and enhancement of non-federally owned districts, sites, buildings, structures, and objects of historical, archeological, architectural, or cultural significance.

Response:

Maintenance dredging operations, per se, will have no effect on terrestrial areas. Disposal of the dredged materials will take place in a diked disposal area constructed for this purpose by the Corps of Engineers. A Final Environmental Statement for this facility has been prepared and filed with the Council on Environmental Quality. The State Historic Preservation Officer indicated that no cultural resources would be endangered by the proposed action.

4. Comment:

To insure a comprehensive review of historical, cultural, archeological, and architectural resources, the Advisory Council suggests that the final environmental statement contain evidence of contact with the Michigan State Historic Preservation Officer and that a copy of his comments concerning the effects of the undertaking upon these resources be included in the final statement.

Response:

The State Historic Preservation Officer has been contacted. That agency's review concluded that these projects will have no effect on cultural resources. See letter of September 29, 1975 included in Appendix E.

U.S. Department of Agriculture - Forest Service

1. Comment:

Since the above project has no direct effect on woodland and minor indirect effects, we have no comments.

Response:

Your reply is noted and has been included in the FEIS.

U.S. Department of Agriculture - Soil Conservation Service

1. Comment:

We have reviewed the draft environmental impact statement and do not have any comments.

Response:

Your reply is noted and has been included in the FEIS.

U.S. Environmental Protection Agency (EPA)

1. Comment:

Based on information provided in the Draft EIS, we have no major objections to the proposed dredging, but request additional information to more fully assess the total project impact. Based on the above discussion, we have classified the project as LO (Lack of Objection) and Categorized the EIS as 2 (additional information necessary).

Response:

Additional information requested by EPA and other agencies has been furnished in the FEIS. Some information is not presently available (See C/R #2 following) but the proposal to place any dredgings in a deep water disposal site would be negated if the sediments are classified polluted.

2. Comment:

The EIS indicated that the bottom sediment material from approximately 12 miles from the river mouth lakeward was unpolluted. Since our agency has not sampled this area, the status of this material is not known at the present time. We will sample beyond the 12 mile point when we are in the area later this month.

Response:

The results of EPA sample analysis have not been received at this time. If the materials from the outer channel limits are classified polluted, they will be removed and placed in confined disposal facility.

3. Comment:

Since it is proposed to open lake dispose this material during normal maintenance operations, additional information on this portion of the project should be provided. The EIS should detail the quantity of unpolluted material to be dredged, the location of the disposal site, the quality of the aquatic and benthic habitat at the disposal site and whether or not there are potable water intakes near the disposal site.

Response:

The proposed open-water disposal site for unpolluted sediments is 7 miles due east of the nearest shoreline and 10 1/2 miles from the river mouth; the water is 24-foot in depth or deeper. An annual average of 12,000 cubic yards is dredged in the unclassified section of the outer harbor. Although the specific site has not been surveyed, judgments can be made from examining data from nearby stations. While this site is within the inner bay region, it is far enough into the bay to realize some dilution effects. Pollutant concentrations diminish with distance from the river mouth. Water quality contaminants will be less than in waters closer to the river mouth but are still found in greater amounts than in outer bay waters. The bottom sediments are mainly fine grained silts and organics, similar to the dredgings that will be deposited in the area. The benthos are mainly pollution tolerant with some faculative

species and a small percent of non-tolerant species making their appearance at this distance out in the bay. The closest potable water intake is at least 7 miles distant from the disposal area.

4. Comment:

Material dredged from the 17.5 mile point of the Saginaw River upstream to the project limits will be disposed of on Middle Ground Island. Bay City provides this site, and periodically removes the material to the City's sanitary landfill. These polluted materials, when disposed of at the sanitary landfill, should be covered by an impervious material to prevent pollutants from re-entering any watercourse.

Response:

These materials will be covered with a five-foot thick layer of impervious clay according to prevailing regulations governing landfill operation. The City is currently using the dredged material with alternate layers of refuge to construct a ski hill on Middle Ground Island. The City will cover the hill with layers of clay, seed, and landscape as required by the Michigan Department of Natural Resource's (MDNR) permit.

U. S. Department of the Interior

1. Comment:

The statement adequately describes probable impacts on fish and wildlife resources that will occur as a result of project activities in the Saginaw River and Saginaw Bay.

Response:

Much of the information included in the EIS was obtained from surveys accomplished by the F&WS Great Lakes Fishery Laboratory, Ann Arbor, Michigan.

2. Comment:

No evaluation of cultural resources has been presented in this statement. The EIS should include a statement that no properties listed on or eligible for nomination to the National Register of Historic Places would be affected by the project. The Corps of Engineers should make this determination by checking the National Register and its monthly supplements and by consulting with the State Historic Preservation Officer. If listed properties would be affected, the procedures of the Advisory Council on Historic Preservation (36 CFR 800) must be followed.

Response:

Note C/R #1, Advisory Council on Historic Preservation. The National Register has been checked and the SHPO has been contacted, note letter in Appendix E.

3. Comment:

Conclusions on the presence or absence of archeological resources within the project area based on professional consultation and investigation should be presented in the statement. We recommend that the Corps of Engineers contact the State Archeologist, Dr. James E. Fitting, for assistance in this regard.

Response:

The responsible State agency has been consulted as indicated previously in C/R #2. Incidentally, Dr. Fitting is no longer in that capacity.

4. Comment:

We suggest that Section 3, paragraph 3.03, include identification of the agency which will manage the newly formed project lands.

Response:

This information has been clarified in the FEIS: following completion of the project after ten years for disposal use, the island would be taken over by Bay County, having provided the necessary assurances to the MDNR and to the Federal government as required by P.L. 91-611 prior to construction.

U. S. Department of Transportation, Federal Highway Administration

1. Comment:

The EIS does not comment on the effects of dredging near highway or other structures within the project area. Our concern is that the dredging operations could create scour patterns or possibly undermine the footings of piers or abutments of such structures. If no adverse effects are anticipated, an affirmative statement and the basis for it should be included in the statement.

Response:

Information concerning such impacts on bridge structures - or the lack of any - is provided in Section III, FEIS. Since the navigation

channel pre-dates most of these structures, the bridges are constructed with full consideration of the channel dimensions. Channel deepening projects are not undertaken without full soil and foundation investigations. Additionally, until 1966, permits were required from the Secretary of the Army acting through the Corps of Engineers for all structures crossing a navigable waterway. This function has since been transferred to the U. S. Coast Guard but such permit requests are still subject to review by the Corps for compatibility with existing or proposed navigational uses.

State Agencies

Michigan Department of Natural Resources

1. Comment:

We have reviewed the draft environmental impact statement for the proposed maintenance dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan. We find the statement to be generally adequate in describing the environmental impacts associated with the project. However, additional information and clarification is needed in some areas.

Response:

Additional information has been added in many sections of the FEIS. We hope this clarifies the proposed project advantages and disadvantages.

2. Comment:

It is stated (Page 2, DEIS) that the disposal of polluted river bottom sediments will continue to be placed in a diked area on Middle Ground Island adjacent to the Bay City Solid Waste Disposal Facility. This is an annual volume of approximately 150,000 cu. yd. The dredged material has been allowed for use (in dry form) for daily or supplemental cover purposes at the solid waste facility, but not for use as a final cover. The report states that "the length of service of Middle Ground Island as a disposal site depends on both the quantity of materials deposited at the site and the amounts removed." Please be advised that the remaining life expectancy of the Bay City Landfill is about two years. Because no consideration is likely to be given to expansion of the landfill at this location, it would appear that this situation would have an effect on the proposed project. This should be addressed in the environmental statement.

Response:

Once the Bay City Landfill has reached its capacity and can no longer be used for the placement of dredge spoil, other disposal areas

will have to be located, since Middle Ground Island has a limited capacity of approximately 140-150,000 cubic yards. This initial design has been altered by the construction of a ski hill. The City will cover the hill with layers of clay, seed and landscape as required by the MDNR permit. No definite selections have been determined at this time for further alternate disposal sites. This information has been added to the FEIS.

3. Comment:

Additionally, no description is provided in regard to the type and quality of retention areas at the disposal sites. A full description along with construction specifications should be provided. This would include the type of containment and type of weir, along with retention times and dewatering modes. It must be assured that pollution is not returned to the aquatic systems via the leachate.

Response:

The disposal site is owned and operated by the City of Bay City. Construction specifications are in their possession. The disposal site is constructed with two six-acre cells. Each cell contains an overflow weir. Generally, slurried fill is placed in one cell until it is full and then the other cell is filled while the first dries. Retention times vary as the cells become progressively filled. In certain cases, depending on sediment composition, the overflow water is discharged to the second cell to increase retention time before being discharged to the river. Plans have not yet been formulated on the type of weir or monitoring that will be utilized at the new CDF.

4. Comment:

The information provided on the amount of waterborne commerce via the Saginaw River Channel is not complete. It is stated that 4 million tons of cargo passed through the river channel during 1973 (page 19). However, no information is given, either in the text or in Table 8 (pages 36, 37), as to the point of destination of these commodities along the Saginaw River. A "point of destination" category should be added to Table 8 (page 37) to identify the point of unloading of these commodities.

Response:

Information concerning product deliveries to specific destinations is not readily available. But we can indicate products received versus shipments. Main receipts are coal, crushed limestone, cement, sand/gravel, petroleum products and pig iron. These items are destined for, respectively, Consumers Power Company, the several sand and stone storage yards located in Bay City and the Saginaw environs, Aetna & Huron Portland Cement Companies, the G. M. foundries in Saginaw, numerous oil

storage tanks of several major oil companies, and the G. M. foundries and other fabricators. Shipments are comprised mainly of corn, beans, chemical products, and iron and steel scrap for Canadian and overseas markets. Of course, the agricultural products originate from the Saginaw Valley-Thumb area farms and are shipped through the Wickes Grain Terminals primarily; chemical products from Dow Chemical and iron-steel scrap from the foundries and scrap yards. It should be pointed out that with the completion of pipelines into the Bay City area, petroleum products shipped by vessel have declined appreciably. Some of this information has been added to the FEIS. See Table 8 page 73 A.

5. Comment:

Alternative modes (i.e. rail, trucking) of transporting commodities to points upriver should be treated in the "Alternatives" section on page 21. The cost of rail or truck shipment (from a point near the mouth of the River) should be balanced against the cost of dredging some 19 miles of river from Saginaw to lower Bay City. The cost of constructing, operating and maintaining a confined disposal site of larger capacity should also be determined and presented in this section.

Response:

As explained in C/R #6 following, the cost of channel maintenance with the use of confined disposal facilities approximates one dollar per ton of commerce. Although we cannot present specific figures at this time, our experience tells us that the costs involved in unloading from ship to truck or rail, transporting these bulk commodities to destinations up stream by truck or rail, and unloading once again could not be done for less than the cost of channel maintenance. As mandated by Sec. 123, P.L. 91-611, the Secretary of the Army, acting through the Chief of Engineers, is authorized to construct, operate, and maintain contained spoil disposal facilities of sufficient capacity for a period not to exceed ten years. We are not authorized to construct disposal sites of larger capacity.

6. Comment:

It is mentioned (under alternatives) that the costs of waterborne transport would rise if the channel were not dredged. It should also be mentioned this might be balanced by the reduction of maintenance and disposal costs if the maintenance were discontinued or reduced in scale.

Response:

This theory was not mentioned because it would not be a factual representation of navigation economics in the Saginaw River and Bay. Let

us present the following data: A recent study[1] has indicated that revenues developed as a result of waterborne commerce through the Port of Bay County were equivalent to some $23/ton of commerce. 4,180,075 tons were transported via this waterway in 1974. Costs to the Federal government for maintaining the navigation channels were estimated to be $4.37/c.y. (Mar. 75) including amortization expenses for the cost of the new confined disposal facility. If one million yards are dredged, this would mean an expenditure of $4,370,000 or slightly more than $1.00 per ton of commerce for maintenance expenses. For every dollar spent on channel maintenance, almost $23 in revenues are generated into the community. Most new vessels, which are designed to take advantage of the greater depths available in the St. Lawrence Seaway-Great Lakes Connecting Channels, operate at lower cost per ton only when loaded at or near maximum capacity. Reducing the controlling depths for navigation would only eliminate a large number of ships that could use the port which, in turn, would reduce the commerce substantially. The reduction in maintenance costs would not be proportionate because of the fixed costs of plant, equipment, and manpower that would be carried nevertheless.

7. Comment:

The alternatives for the project (page 21) do not include alternate sites for disposal. We are especially concerned that on-land disposal is not treated in the statement as an environmentally desirable alternative. In the long run this method would be the cheapest and easiest to build and maintain. Have on-land disposal sites been sought and considered? If on-land sites have been considered and rejected, or have not been available, this should be covered in the statement.

Response:

Alternative sites were considered as a separate study. Please see paragraph 1.07, FEIS.

8. Comment:

Because of shallow depth of the inner bay and its importance to productivity for fish and wildlife, we feel open water disposal is detrimental to the aquatic biota. Therefore, further investigation is needed to determine a more satisfactory method of disposal. This need should be addressed in the environmental statement. Also, more specific information is needed (in addition to fish surveys) as to how fish will be affected

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[1] Novey & Sarkar, Economic Benefits of the Winter Navigation Extended Season to the Port of Bay County, 1976-1980 period, Department of Economics, Saginaw Valley State College.

by the project. For example, what are the times of dredging and which species may be affected and to what degree? This information should be included.

Response:

No open water disposal will be utilized in 1976. The U. S. EPA has sampled the outer channel and if this area is classified as polluted, it will be contained. The impacts of open water disposal of unpolluted sediments have been addressed in Section 2. The effects of open water disposal on fish production is uncertain. However, commercial fishermen have long recognized the value of some of these disposal sites and frequently concentrated their netting efforts during the following year at these areas. Researchers have shown that fish tend to avoid areas of high turbidity and seek more suitable environmental conditions. See Sections 2, 4, 5 for additional information.

9. Comment:

It appears that deposition of polluted dredgings on Channel and Shelter islands would disrupt the nesting activity of as many as 10,000 gulls. The creation of a larger island would only be beneficial to gulls if it were left undisturbed and not subjected to the proposed human uses such as boating, camping, picnicking, etc. The environmental statement should comment on the timing of proposed construction and disposal (gull nesting) and the limiting factors of the proposed recreational uses (access, maintenance, etc.) in more detail in the final statement.

Response:

These islands, created in the first place by the disposal of dredged material, will be impacted upon when construction of the proposed CDF occurs. Construction times, disposal activities and recreational uses have not yet been finalized. Please see Sec. 3, Relationship of Action to Land Use Plans, and the U.S. Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan for more details. The stone dikes which will enclose the new disposal site should enhance the habitat for gulls.

10. Comment:

Page 8 - 2.17 (DEIS)

It is stated that an average of 7000 waterfowl hunters use the bay area annually. If this information was supplied by us we apologize for the error. Our state surveys indicate that an average of 14,345 waterfowl hunters annually used Saginaw Bay habitats during 1965-74. The average annual hunter days involved was 106,234. Duck Stamp sales for

counties adjoining the Bay would be low estimates of use because they don't take into account hunter use of the area from more distant, populous, urban counties. This information should be corrected in the final EIS.

Response:

The aforementioned has been addressed in this revised text. Refer to Section 2, paragraph 2.17.

11. Comment:

Page 9-2.17 (DEIS)

The following data should be substituted for acreage of state game and wildlife areas given.

Tobico Marsh State Game Area	1,848 acres
Nayanquing Point Wildlife Area	1,146 acres
Quanicassee Bay Wildlife Area	218 acres
Wigwam Bay Wildlife Area	146 acres
Waterfowl Bay Wildlife Area	1,790 acres
Fish Point Wildlife Area	3,076 acres

Response:

This information has been added to the FEIS.

12. Comment:

Page 14-3.02 (DEIS)

What effect will the project have on the actively eroding condition of Shelter and Channel Islands?

Response:

Ongoing work will have little, if any, impact on the existing erosional characteristics of the area. However, with the incorporation of both Shelter and Channel Islands into the proposed diked disposal facility, the eroding condition of the islands will be mitigated due to protection provided by the armored shoreline of the enlarged disposal area.

13. Comment:

Page 17 - 4.08 (DEIS)

More detail is needed concerning the problem of botulism mentioned in this section. How does the Corps propose to implement the

"remedial actions" which may include flooding or drying? Where is the plan to implement such action? This should be included in the statement.

Response:

Wildfowl infrequently use the disposal site. However, if botulism broke out, filling of the contaminated cell would cease to allow for drying of the sediments. The pumpout pipeline would be transferred to the other cells so disposal operations could continue. Plans and specs for the new confined disposal site have not been finalized. When these plans are complete, a description of the procedures for remedial action at the CDF can be provided.

14. Comment:

Page 19 - 4.14 (DEIS)

No mention is made as to the relationship of the project to flood relief along the Saginaw River. Is this a factor?

Response:

No. Maintenance dredging will not affect the flood stages of the Saginaw River.

15. Comment:

Page [illegible] - 7.04 (DEIS)

This information also represents an unavoidable adverse effect on the project and should be included in that section on page 20.

Response:

This information has been added to Section 5.

16. Comment:

Page 23 - 6.01 and 6.02 (DEIS)

We find no basis in fact for two statements made in these sections. It is stated: (1) that the bottom will return to original status once dredging is terminated, and (2) the fact that maintenance dredging is recurrent is proof that original conditions will return if dredging was discontinued. These statements need to be explained in more detail.

Response:

Additional information has been added to clarify these paragraphs in question in the FEIS.

Michigan Department of State Highways & Transportation

1. Comment:

Although the Statement points up the obvious need for the project, we feel that discussions of the environmental setting, probable impacts and alternatives considered are inadequate. In general, all sections in the Statement are too brief to adequately describe the impact of the project. Therefore, we suggest that in preparation of the Final Statement, all sections be examined for such deficiencies.

Response:

All sections of the Draft EIS have been re-evaluated and revised as required commensurate with the scope of this ongoing project and to the extent existing information permits. In the development of plans for operation, maintenance, and management activities, all significant effects on the environment are considered. Such considerations differ from those for a project in planning status and discussion need address only the environmental effects of the project operation.

2. Comment:

It is given in DEIS that approximately 840,000 cubic yards of material, most of which is polluted, will be dredged. Locations for disposal of only 140,000 cubic yards of polluted material and the small amount of unpolluted material are given. It is difficult to assess the total impact of this project without information concerning location(s) of confined disposal for the remaining polluted material.

Response:

The confined disposal facility to receive the major volume of polluted sediments is mentioned in paragraph 1.04, 3.02, 3.03 and 4.11 and Figure 6 of the DEIS. The statement in 1.04 of the FEIS will be made more definitive. For a more detailed description of this approved site, the Final Environmental Statement, Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan, which was filed with CEQ on 29 May 1975, should be consulted.

3. Comment:

The Ecology Section mentioned State Game Areas considerably outside of the project area, but failed to recognize the existence of

Crow Island State Game Area which is within the project area. It is suggested that the importance of the Crow Island State Game Area and the probable impacts of the proposed action on it be discussed.

Response:

The Crow Island State Game Area is a flood plain marsh area separated from the Saginaw River by the roadbed of Highway M-13. It is only linked to the channel by two outlet canals. Water levels in the marsh are probably controlled by the levels in the river. Since this game area was established after the existence of the navigation channel, the life in the marsh must have been compatible with the utilization of the navigational waterway. The planned maintenance work does not propose any operations that have not been done in the past, so we do not anticipate any unique impacts on this State Game Area which is also straddled on the south end by the Expressway I-75 as well as M-13 on the west and a railroad on the east side.

4. Comment:

The description of the fisheries resource of the Saginaw River Drainage Basin should include mention of recent releases of steelhead trout and coho and chinook salmon in the Cass River. These introductions have been very successful, despite the necessity that the fish pass through the heavily industrialized Saginaw River corridor during migration between Lake Huron and upstream spawning areas. Since the project proposal could adversely affect these migrations, the possibility of such adverse effects occurring should be evaluated.

Response:

This information will be placed in the FEIS. The project could impact adversely on these migrations if the dredging operation occurred at the same time as the fish migration periods. Dredging in Saginaw River and Bay usually is performed in mid-summer. There should be little conflict with fish migrations at that time. If the introductions have been successful, as you have stated, then the fish are apparently surviving the vicissitudes of the existing maintenance operations.

5. Comment:

The discussion of the relationship of the proposed project to proposed area land use plans should be more specific. First, the Statement indicates that polluted material from Middle Ground Island will be removed to the city's sanitary landfill. Although such a procedure may be desirable, it is contingent upon the content of residual pollution in

the fill, and the capacity of the landfill to confine such pollutants. Therefore, both the condition of the fill and the limitations of the landfill should be discussed.

Response:

The landfill is a sanitary fill operated by the City of Bay City under regulatory guidelines of the State of Michigan. The dredged material taken from Middle Ground disposal area is used as a cover over the daily deposits of garbage placed by the city. The dredgings are dewatered and dry before being transferred to landfill. Such operations, we trust, are done in conformance with local, county, and State regulations. Clay sealers are placed over the fill after a given number of lifts are accomplished and will also be placed on top of the landfill when full. We understand the city's landfill area has 2-3 years' capacity remaining. The landfill is being utilized to construct a ski hill for Bay City recreation and the operation, we understand, is permitted by MDNR.

6. Comment:

Second, it is acknowledged that 355 acres of bottom lands will be filled and that this is acceptable because the land may be useful for future recreational purposes. These future recreational uses are only vaguely described. Attempting to assuage the impacts of filling these bottom lands and open water areas with vague references to future recreational use does not address the impacts of filling these areas.

Response:

Following completion of the use of the confined disposal facility (CDF), which is being designed to hold a 10-year volume of dredged material, the island would be taken over by Bay County, having provided the necessary assurances to the MDNR and to the Federal government as required by P.L. 91-611 prior to construction of the facility. Present planning by the local government is to create a recreational resource for the area on the island. Beyond that, no more definitive plans have been finalized.

7. Comment:

The Statement cites that "During construction of the disposal site, fish using the Shelter-Channel Islands for spawning and rearing activities will be required to use other areas." Anthropomorphic statements such as this greatly reduce the credibility of the Statement. The Statement should simply indicate that project implementation will, at least temporarily, destroy fish spawning areas, and that the size of future fish populations may be reduced.

Response:

This statement was mostly speculation, since the waters around the existing disposal islands have never been identified as spawning or rearing habitat for particular species of fish. However, a statement that did not attribute human characteristics to animal life would be better made and so the phrase has been revised in the FEIS.

8. Comment:

The Environmental Protection Agency indicates in their letter on page D-9 that the use of hopper dredges should be avoided in polluted harbors because they allow fine materials to be discharged during the concentrating of solids in the hoppers. The Alternative Section fails to mention that the use of mechanical dredges would have an advantage over hopper dredges in this regard.

Response:

The Corps does not believe there is a significant environmental advantage to using a mechanical dredge in this area that would compensate for the economic and time differences between the two methods. The soft sediments dredged here would leak from the bucket, spill from the barge as it is transported, and once again drain from the bucket as it is removed from barge to disposal site. Thus several areas are contaminated with the polluted spoil, whereas the discharge from the hopper dredge remains in the general area of the dredging.

Michigan Department of State History Division and State Historic Preservation Officer

1. Comment:

Dr. Lawrence Finfer, Environmental Review Coordinator, has reviewed the proposals for maintenance dredging and disposal in the following areas:

Lake St. Clair
St. Clair River
Saginaw Bay/River
St. Marys River/Straits of Mackinac
Grand Haven Harbor/Grand River

He concludes that these projects will have no effect on cultural resources. Thank you for giving us the opportunity to comment.

Response:

Your reply is noted and the conclusions have been included in the FEIS.

Saginaw-Midland Water Supply System, Bay City, Michigan

1. Comment:

All dredged material should be delivered into the diked disposal area. The Draft Environmental Statement says that only a small portion of the average annual shoaling volume is non-polluted. Disposal of this small volume in the open water disposal area shown in Figure 2 is our objection. No sharp line isolates polluted areas. Validity of the non-polluted material presumption is uncertain. No open water disposal should be allowed, since the small amount of material presumed non-polluting will have little effect on the overall project cost if placed in the diked disposal area.

Response:

The U.S. EPA has tested this unclassified portion of the navigation channel and we are awaiting those results. If the material is polluted, it will be confined. However, if the sediments are classified as unpolluted and suitable for open water disposal, no significant water degradation should occur since your water intake is some seven miles from the proposed open water disposal site and the quantities for disposal are not large. Filling the CDF with unpolluted dredgings would reduce its capacity and impair its ability to contain polluted sediments over the 10 year life span of the project. If problems ever occur because of the dredging/disposal operations, notify the District Engineer and operations will be suspended until the matter can be corrected.

TABLE 1

Average Monthly Water Temperature, °F, Bay City Water Plant

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
January	34	38	33	35	35	35	34	33	33	33	36	36	33	35
February	34	41	34	37	34	37	37	33	37	35	38	39	35	35
March	34	36	35	40	34	37	37	34	38	38	40	34	38	38
April	40	41	39	43	43	39	43	41	45	42	41	42	38	46
May	53	53	55	54	59	57	51	55	54	54	57	54	58	57
June	65	63	66	67	67	64	64	64	64	62	66	66	65	68
July	71	72	71	74	74	71	73	69	69	72	73	72	72	68
August	71	72	69	70	68	69	70	69	72	74	76	70	70	
September	68	69	65	63	63	63	65	64	68	68	68	66	67	
October	56	56	58	59	50	52	52	52	58	56	59	57	52	
November	44	44	41	47	45	43	40	41	44	44	50	43	38	
December	35	34	34	34	32	35	33	34	34	38	38	33	32	

From Consumers Power Company 1974.

Note - Intake is 18,800 ft. from shore at depth of 17 ft.

TABLE 2

Maximum Water Temperature, °F, Bay City Water Plant

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
January	34	40	34	36	37	36	36	33	34	33	37	36	35	35
February	34	42	35	38	35	39	39	33	40	38	39	40	37	36
March	36	42	37	42	36	40	40	35	40	40	42	36	39	44
April	52	49	48	51	54	47	53	50	53	48	51	48	49	55
May	65	58	64	59	64	64	58	57	58	61	62	59	70	65
June	69	68	72	76	74	70	73	70	72	66	69	74	70	71
July	76	75	73	78	80	73	76	72	73	76	74	74	76	75
August	74	74	71	74	77	74	74	72	75	76	80	74	75	79
September	73	75	71	67	63	66	70	68	70	74	73	73	73	
October	61	62	60	60	57	58	57	56	65	62	62	63	60	
November	49	51	48	54	50	47	46	46	49	48	57	55	43	
December	39	38	39	40	33	38	36	34	40	38	43	36	36	

From Consumers Power Company, 1974.

Note - Intake is 18,800 ft. from shore at depth of 17 ft.

TABLE 3 Lake Huron [illegible] Depth. Data for each parameter are given as the mean ± one standard deviation followed by the number of observations.

	Zone I	Zone II	Zone III	Zone IV
Specific conductance, μmho at 25°C	192 ± 8.0 (7)	193 ± 5.7 (8)	247 ± 20 (6)	211 ± 2.7 (5)
Transparency, m	9.1 ± 2.4 (7)	8.6 ± 2.4 (6)	1.80 ± 0.40 (6)	5.9 ± 0.62 (5)
pH	8.50 ± 0.01 (7)[a]	8.38 ± 0.16 (24)	8.65 ± 0.17 (18)	8.49 ± 0.06 (15)
Alkalinity, ppm	76.5 ± 1.9 (25)	76.5 ± 6.7 (24)	88.6 ± 3.7 (18)	82.5 ± 1.2 (15)
Calcium, ppm	21.2 ± 1.7 (21)	26.5 ± 0.58 (24)	30.3 ± 1.7 (18)	28.0 ± 0.76 (13)
Chloride, ppm	4.65 ± 1.5 (21)	5.58 ± 0.94 (23)	10.6 ± 2.3 (18)	6.6 ± 1.4 (16)
Sulfate, ppm	-----	10.0 (1)[a]	12.8 ± 1.8 (5)[a]	10.9 ± 0.72 (12)
Chlorophyll *a*, μg at 3 m	0.81 ± 0.72 (7)	0.60 ± 0.40 (8)	7.26 ± 3.1 (6)	0.85 ± 0.04 (4)
Carbon fixation, mg C/m³/hr at 0 m	0.61 ± 0.28 (4)	0.93 ± 0.42 (5)	31 ± 23 (5)	1.03 ± 0.26 (4)
at 3 m	0.77 ± 0.39 (4)	1.69 ± 0.81 (5)	21 ± 17 (5)	1.50 ± 0.53 (4)
Assimilation ratio, mg C/hr/mg Chl *a*	1.26 ± 1.0 (4)	2.61 ± 1.4 (5)	4.16 ± 2.5 (5)	1.76 ± 0.63 (4)

[a]Surface only. (from Schelske and Roth, 1973)

TABLE 4

SAGINAW BAY SPORTS CATCH

Species	1971	1972
Perch	393,000	962,000
Walleye	4,000	2,000
Bass	--	13[illegible]
Panfish	--	5[illegible]
Northern Pike	58,000	39,000
Suckers	--	87,000
Smelt	--	391,000
Rainbow/Steelhead	500	900
Lake Trout	1,000	0
Brown Trout	600	0
Coho	1,000	0
Chinook	2,000	0
Other Species	2,000	94,000
Total	920,100	1,761,000
Angler-Days	358,360	499,800
Fisherman	48,920	88,910
Average Days per Fisherman	7.33	5.62

From Consumers Power Company, 1974.

TABLE 5

COMMERCIAL FISH CATCH IN SAGINAW BAY
1960 - 1971
(Thousands of Pounds)

Species	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Lake Sturgeon	*	-	-	*	*	*	*	*	-	*	-	
Lake Herring	39	58	18	1	1	*	*	-	-	-	-	
Chubs	381	635	285	110	27	21	5	6	*	*	-	
Lake Whitefish	54	80	6	12	28	3	1	26	10	16	8	5
Round Whitefish	-	-	-	-	-	2	8	*	*	*	-	
Lake Trout	-	-	-	-	-	-	-	-	-	-	-	
[illegible]	75	31	25	12	32	24	30	52	27	63	-	
Northern Pike	130	176	67	20	15	6	1	-	-	-	-	
[illegible]	1285	1401	1558	1536	938	1384	769	866	1011	1257	1224	1284
Suckers	379	518	663	872	399	353	299	219	189	123	138	132
Channel Catfish	270	238	175	171	153	145	164	123	101	121	226	365
Bullheads	2	12	10	6	8	2	1	3	10	28	56	65
Rock Bass	7	6	6	9	7	3	2	1	1	1	1	1
[illegible] Perch	271	820	229	278	675	895	1221	1087	846	748	536	597
[illegible]	32	36	85	65	62	25	17	17	11	-	-	-
[illegible]	*	-	*	*	-	*	-	-	-	-	-	-
Sheepshead	17	20	12	13	17	10	8	3	6	11	12	9
[illegible]									1	*	*	*
[illegible]									5	7	10	89
Gizzard Shad									1	1	-	*
Quillback									14	28	21	21
White Bass									*	2	*	1
Yellow Pike									11	9	*	
Alewives										*	-	-
Buffalofish											*	-
Burbot											*	*
All Species	2962	2931	2599	2718	2348	2885	2557	2412	2196	2617	2227	2616

Blanks - No Data
- Means Zero
* Less Than 500 Lb

From Consumers Power Company, 1974.

TABLE 6

KARN-WEADOCK TRAWL DATA

Date & Station	Haul No	Time	Species	No	Weight	Length
5-30-73						
1	1	10:30 AM	Carp	1		[illegible]
			Redhorse Sucker	1		12"
			Channel Catfish	1		8"
			Alewife	1		
	2	10:50 AM	Carp	1		16"
			Channel Catfish	3		8-10"
			Trout Perch	6		
			Alewives	7		
	3	11:05 AM	Channel Catfish	2		8"
			Redhorse Suckers	2		10-15"
			Trout Perch	1		
			Alewives	2		
5-31-73						
2	1	10:30 AM	Carp	5	8-20 Lb	
			Channel Catfish	25		<6"
			Alewives	15		4-6"
			Spottail Shiners	129		3-4"
			Black Bullhead	1		10"
	2	10:50 AM	Carp	1	9 Lb	
			Channel Catfish	2		8"
			Alewives	5		5-6"
			Spottail Shiners	14		~4"
	3	11:05 AM	Channel Catfish	5		~8"
			Alewives	6		5-6"
			Spottail Shiners	5		~4"
3	1	11:20 AM	Carp	1		20"
			Perch	1		5"
			Trout Perch	9		3.5-4"
			Alewives	4		5-7"
			Spottail Shiners	4		~4"
	2	11:35 AM	Carp	4		16-24"
			Alewives	23		
			Trout Perch	12		
			Spottail Shiners	11		
	3	11:45 AM	Carp	1		16"
			Trout Perch	3		

TABLE 6 (Contd)

Date & Station	Haul No	Time	Species	No	Weight	Length
5-31-73 (Contd)						
4	1	12:15 PM	Alewives	5		6-8"
	2	12:25 PM	Alewives	6		6-8"
			Spottail Shiner	1		~4"
			Trout Perch	1		5"
7-12-73						
1	1	11:20 AM	Suckers	6		1-6"
			Alewives	24		5-7"
			Channel Catfish	1		6"
			Trout Perch	2		3-4"
	2	11:30 AM	Alewives	24		5-7"
			Channel Catfish	1		5"
			Perch	1		5"
	3	11:50 AM	Alewives	9		5-7"
			Channel Catfish	1		6"
7-10-73						
2	1	2:08 PM	Channel Catfish	3		2 - 8", 1 - 14"
			Carp	2		14"
			Alewives	40		4"
			Largemouth Bass	1		14"
			Spottail Shiners	75		~5"
	2	2:26 PM	Channel Catfish	3		7-8"
			Carp	3		12-18"
			Alewives	24		4-5"
			Spottail Shiners	122		1-5"
			Perch	4		~1"
	3	2:58 PM	Channel Catfish	4		8"
			Carp	2		13"
			Alewives	27		4-5"
			Spottail Shiners	83		1-4"
3	1	12:35 PM	Carp	4	4 Lb	20"
					3.5 Lb	19"
					2.5 Lb	16"
					1.5 Lb	12"
			Perch	1		7"
			Alewives	4		7"
			Spottail Shiners	9		5-6"
			Northern Pike	1		6"

TABLE 6 (Contd)

Date & Station	Haul No	Time	Species	No	Weight	Length
7-10-73 (Contd)						
3	2	12:50 PM	Carp	4	11 Lb	24"
					4 Lb	20"
					3 Lb	18"
					2 Lb	15"
			Perch	6		4-10"
			Yellow Bullhead	1		9"
			Alewives	5		3 - 7", 2 - 4"
			Spottail Shiners	9		4-5"
	3	1:52 PM	Carp	9	1-5.5 Lb	10-24"
			Perch	2		4-5"
			Channel Catfish	1		7"
			Alewives	12		7"
			Spottail Shiners	29		3-4"
			Rock Bass	1	6 Oz	10"
4	1	12:00 AM	0			
	2	12:08 AM	Alewives	3		7"
			Spottail Shiner	1		5"
	3	12:18 PM	Alewives	3		7"
			Spottail Shiner	1		4"
5	1	10:12 AM	0			
	2	10:20 AM	0			
	3	10:37 AM	Alewife	1		5"
6	1	11:03 AM	0			
	2	11:10 AM	0			
	3	11:18 AM	0			
	4	11:30 AM	0			
8-22-73						
2	1	10:45 AM	Carp	1	3 Lb	13"
				8		4-6"
			Channel Catfish	3		9-12"
				13		5-7"
				45		3-5"
			Yellow Bullhead	2		5-7"
			Black Bullhead	3		5-7"

TABLE 6 (Contd)

Date & Station	Haul No	Time	Species	No	Weight	Length
8-22-73 (Contd)						
2	1	10:45 AM	Gizzard Shad	18		3-5"
			White Bass	4		1-3"
			Perch	4		4-6"
			Spottail Shiners	6		1-2"
			Crappie	3		1-3"
			River Chub	1		7-9"
	2	11:45 AM	Carp	1		16"
			Yellow Bullhead	2		9-11"
			Perch	1		4"
			Striped Bass	1		3"
			Shad	7		3-5"
			Perch	1		2"
			Rock Bass	3		4-6"
			Channel Catfish	1		9-7"
				16		3-5"
	3	12:15 PM	Channel Catfish	6		3-5"
			Perch	2		2", 8"
			Yellow Bullhead	2		8"
			Gizzard Shad	228		3-5"
8-21-73						
4	1	12:30 PM	Channel Catfish	1		16"
			Perch	6		2 - 5-7", 4 - 1-2"
			Rock Bass	1		1"
			Trout Perch	1		3-5"
	2	1:00 PM	Carp	2		16"
			Rock Bass	2		1"
			Spottail Shiner	3		1"
			Perch	1		1"
	3	1:25 PM	Channel Catfish	1		7-9"
			Carp	1		16"
			Rock Bass	2		1"
			Perch	1		5"
8-22-73						
5	1	1:30 PM	Yellow Bullhead	1		10"
			Perch	7		3 - 1-3", 4 - 5-7"
			Gizzard Shad	1		4"
			Spottail Shiners	6		2"
	2	2:00 PM	White Sucker	1	3 Lb	24"
			Perch	1		4"
			Spottail Shiners	2		1", 3"

From Consumers Power Company, 1974.

TABLE NUMBER 7

POPULATION DISTRIBUTION OF THE SIX COUNTY AREA AND ADJACENT CITIES SURROUNDING SAGINAW BAY AND THE SAGINAW RIVER

CITY	1970 POPULATION
Bay City	49,449
Carrollton	8,526
Essexville	4,990
Saginaw	91,845
Zilwaukee	2,074

COUNTY	1970 POPULATION
Arenac	11,149
Bay	117,339
Huron	34,083
Iosco	24,905
Saginaw	219,743
Tuscola	48,603

TABLE NUMBER 8

WATERBORNE COMMERCE OF THE UNITED STATES, 1964 - 1974. TOTAL TONNAGE THROUGH THE SAGINAW RIVER

YEAR	TOTAL TONNAGE
1964	5,874,386
1965	7,003,601
1966	7,243,288
1967	6,562,463
1968	5,228,842
1969	5,098,710
1970	4,616,434
1971	4,847,133
1972	4,386,273
1973	4,095,978
1974	4,180,075

(CONTINUED)

Table 8A. Commerce and Market Value of Commerce through the Saginaw River in 1974.

SAGINAW RIVER

1974 COMMERCE AND MARKET
VALUE OF COMMERCE

	Great Lakes		Overseas & Canadian		Local/		Market Value	Total
	Receipts	Shipments	Imports	Exports	Internal	Total	Per Ton	Dollar Value
Coal	364,219					364,219	$ 15.60	$ 5,681,816
Grain				205,725		205,725	$132.84	27,328,509
Limestone	2,301,176			8,400		2,309,576	$ 1.58	3,649,130
Sand/Gravel	48,604				486,579	535,183	$ 1.58	845,589
Cement	145,571					145,571	$ 1.58	230,002
Petroleum Prod.	121,390	80,233	15,981	7		217,611	$ 79.44	17,287,017
General Cargo	197,143		109,462	53,896	7,144	367,645	$300.00	110,293,500
Other Bulk	34,520		15	10		34,545	$ 10.00	345,450
Total	3,212,623	80,233	125,458	268,038	493,723	4,180,075		$165,661,013

Table 8B. Major Commodities Shipped Through the Saginaw River in 1973.

1973 COMMODITIES (MAJOR)	TOTAL TONNAGE
Corn	142,960
Soybeans	69,633
Coal and Lignite	77,401
Limestone	2,366,575
Sand, Gravel, Crushed Rock	542,248
Nonmetallic Minerals	69,287
Benzene and Toluene	37,699
Basic Chemicals and Products	173,417
Gasoline	114,101
Distillate Fuel Oil	98,744
Residual Fuel Oil	61,145
Building Cement	90,124
Pig Iron	114,583
Iron and Steel Scrap	32,228

TABLE NUMBER 9

SEDIMENT ANALYSIS, SAGINAW BAY AND SAGINAW RIVER, JUNE 14, 1975
(SEE FIGURES 1 AND 2 FOR SAMPLING STATION LOCATIONS)

PARAMETER	MAXIMUM ACCEPTABLE VALUES %	SAMPLING STATION NUMBER AND PERCENT OF DRY WEIGHT						
		1	2	4	5	6	7	8
Volatile Solids	6.0	6.2	19.3	17.6	15.8	18.0	18.4	11.0
Chemical Oxygen Demand	5.0	0.5	11.1	6.1	7.9	6.9	6.4	3.6
Total Kjeldahl Nitrogen	0.10	0.07	0.33	0.35	0.31	0.38	0.40	0.25
Oil - Grease	0.15	0.45	2.6	1.0	1.3	1.2	1.5	1.1
Mercury	0.0001	<0.00005	<0.00006	<0.00006	<0.00009	<0.00005	<0.00005	<0.00005
Lead	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zinc	0.005	0.005	0.026	0.006	0.008	0.005	0.006	0.002

TABLE NUMBER 10

GENERAL WATER QUALITY PARAMETERS AND TRACE METAL CONCENTRATIONS.
SAGINAW BAY AND SAGINAW RIVER, JUNE 14, 1975 (SAMPLING STATIONS ON FIGURES 1 AND 2;
ALL CONCENTRATIONS IN mg/l UNLESS OTHERWISE SPECIFIED).

PARAMETER	1	2	3	4	5	6	7	8
Sample Depth	15'	15'	15'	15'	15'	15'	15'	15'
Secchi Disc Transparency	12"	13"	14"	14"	13"	14"	25"	38"
TSS	28	37	31	36	36	41	24	12
Settleable Matter ml/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Turbidity JTU	30	35	35	32	37	43	17	7
Apparent Color P/C Units	93	98	98	98	110	130	45	15
pH	7.95	7.88	7.89	7.88	7.77	7.90	8.01	8.46
Total Hardness as $CaCO_3$	277	277	277	278	274	272	150	147
Total PO_4	0.287	0.310	0.285	0.310	0.327	0.291	0.093	0.067

(CONTINUED)

TABLE NUMBER 10 (CONTINUED)

PARAMETER	1	2	3	4	5	6	7	8
NO_3	0.850	0.850	0.850	0.850	0.650	0.650	0.210	0.155
5 - Day BOD	16	12	13	14	20	16	10	12
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	0.75	0.84	0.69	0.69	0.63	0.70	0.35	0.11
Nickel	0.05	0.02	<0.01	0.03	0.02	0.04	0.02	0.01

TABLE NUMBER 11

TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FROM THE SAGINAW RIVER AND SAGINAW BAY. JUNE 14, 1973 (SEE FIGURES 1 AND 2 FOR SAMPLING STATION LOCATIONS).

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
6th Street Turn Basin				
Station Number 1	Surf	21.7	7.6	85
	1	21.2	7.6	84
	2	21.2	7.5	83
	3	21.0	7.7	86
	4	20.0	7.5	82
	5	21.0	7.5	83
	10	20.8	7.4	82
	15	20.0	6.7	73
	20	20.0	6.2	67
Bottom	25	19.8	6.0	65

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
RN 72				
Station Number 2	Surf	22.0	7.9	90
	1	22.0	7.9	90
	2	22.0	7.7	88
	3	21.7	7.7	88
	4	21.5	6.9	78
	5	21.0	6.8	76
	10	20.0	6.3	68
	15	20.0	6.1	66
	20	19.5	5.7	61
	25	19.5	5.6	60
Bottom	26	19.5	5.6	60

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	(%) % SAT.
12 Mile Point				
Station Number 3	Surf	20.5	6.5	71
	1	20.5	6.5	71
	2	20.5	6.5	71
	3	20.2	6.6	72
	4	20.1	6.2	67
	5	20.1	6.4	70
	10	20.0	6.3	68
	15	20.0	6.0	65
	20	19.8	5.8	63
	25	19.6	5.6	60
Bottom	27	19.6	5.6	60

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
Airport Turn Basin				
Station Number 4	Surf	21.0	7.1	79
	1	20.8	7.1	79
	2	20.7	6.8	76
	3	20.5	6.8	76
	4	20.5	6.7	72
	5	20.5	6.7	72
	10	20.0	6.2	67
	15	19.2	5.8	62
	20	19.2	5.3	56
Bottom	24	19.1	5.3	56

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
Essexville Turn Basin				
Station Number 5	Surf	20.8	6.4	71
	1	20.5	6.3	68
	2	20.5	6.2	68
	3	20.2	6.2	67
	4	20.2	6.2	67
	5	20.1	6.2	67
	10	20.0	5.8	63
	15	19.7	5.8	62
	20	19.5	5.2	56
	25	19.0	5.2	55
Bottom	33	19.0	4.7	50

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
Mouth of Saginaw River RN 34				
Station Number 6	Surf	20.5	6.6	73
	1	20.5	6.6	73
	2	20.0	6.4	70
	3	20.0	6.4	70
	4	20.0	6.4	70
	5	20.0	6.2	67
	10	19.3	5.5	59
	15	19.0	5.5	59
	20	19.0	5.3	56
Bottom	25	19.0	5.4	57

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
RN 28; BC-27				
Station Number 7	Surf	19.6	9.5	102
	1	19.0	9.5	101
	2	19.0	9.5	101
	3	18.8	9.5	101
	4	18.8	9.4	100
	5	18.5	9.4	100
	10	18.0	8.8	93
	15	18.0	8.6	91
	20	18.0	8.4	88
	25	18.0	8.3	87
Bottom	29	18.0	8.2	86

TABLE NUMBER 11 (CONTINUED)

	DEPTH FEET	TEMP °C	DO mg/l	DO % SAT.
RN 18; BC-17				
Station Number 8	Surf	17.5	8.8	92
	1	17.5	8.6	90
	2	17.5	8.5	89
	3	17.5	8.4	88
	4	17.5	8.6	90
	5	17.2	8.6	89
	10	17.2	8.6	89
	15	17.2	8.4	87
	20	17.2	8.3	86
	25	17.0	8.2	85
Bottom	30			

AD-A106 936 CORPS OF ENGINEERS DETROIT MI DETROIT DISTRICT F/G 13/2
MAINTENANCE DREDGING OF THE FEDERAL NAVIGATION CHANNELS IN THE --ETC(U)
DEC 75

UNCLASSIFIED NL

2 of 2

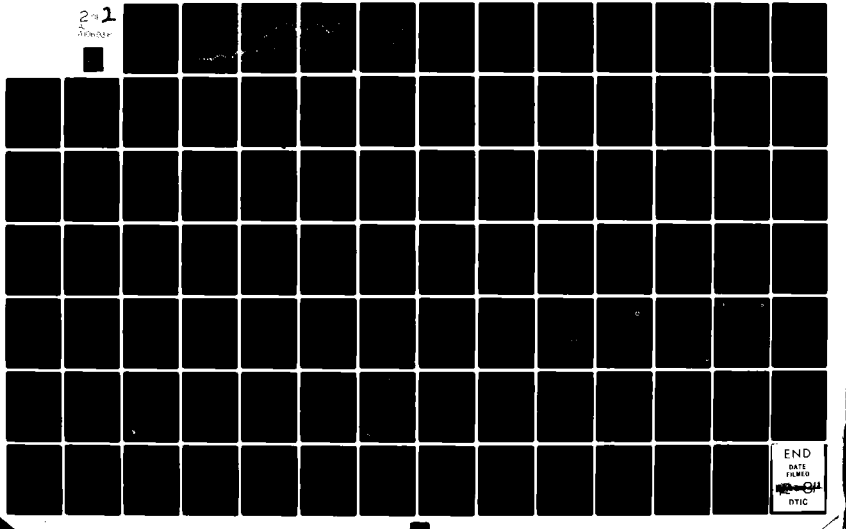


TABLE 12. RESULTS OF BENTHIC SURVEY CONDUCTED JUNE 14. 1975. SAGINAW BAY AND SAGINAW RIVER (See Figures 1 and 2 for Sampling Station Location).

ORGANISM	NUMBER/METER SQUARED							
	Station Number							
	1	2	3*	4	5	6	7	8
**MOLLUSCA								
Pelecypoda (Clams								
Sphaeriidae								
Sphaerium					60			
ANNELIDA								
Oligohaeta (worms)								
Tubificidae	397	377		218	6428	893	1111	2109
ARTHROPODA								
Crustacea								
Amphipoda (scuds)								
Gammarus	40						20	
Insecta								
Diptera								
Chironomidae (midges)	317			20	20	40	139	178

* No Organisms were found in 3 grabs of PONAR dredge.

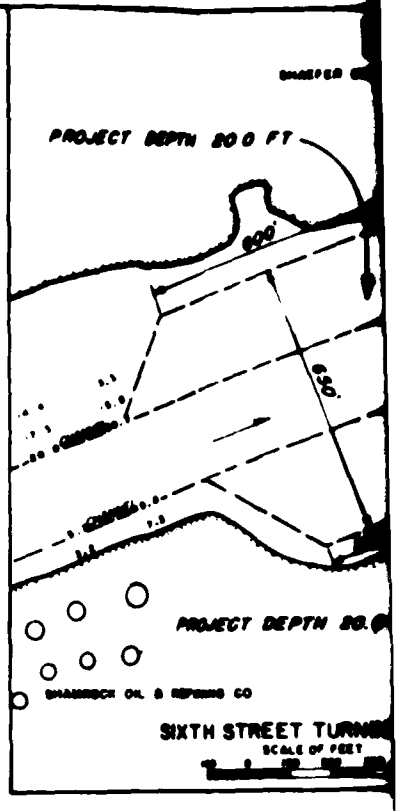
** Several detrital fragments of various snail and clam shells were commonly found at all stations.

CORPS OF ENGINEERS

LEGEND

INDEX TO BRIDGES
SHOWN THUS ●

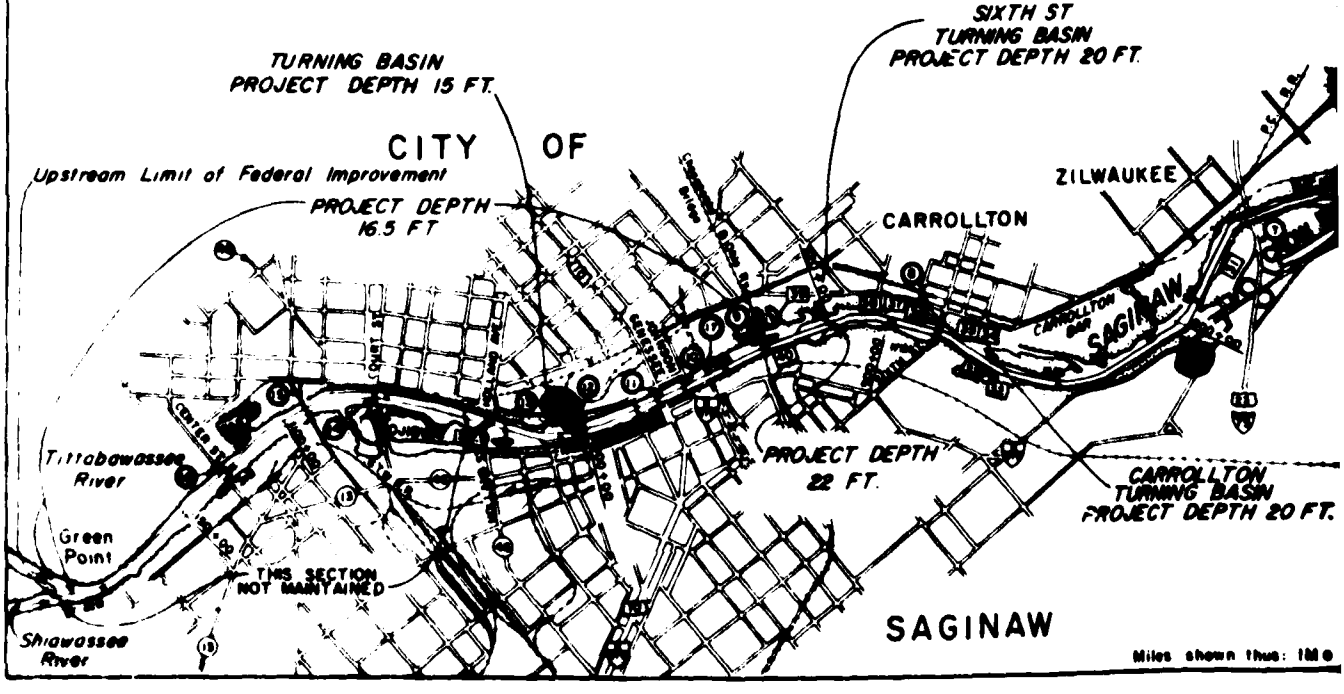
1 DETROIT & MACKINAC RY
2 BELINDA ST
3 PENN CENTRAL R R
4 THIRD ST
5 McKINLEY ST MEMORIAL
6 LAFAYETTE AVE
7 HIGHWAY 23 AT CROW ISLAND
8 SIXTH ST
9 CHESAPEAKE & OHIO RY
10 JOHNSON ST
11 GENESSEE AVE
12 PENN CENTRAL R R
13 HOLLAND AVE
14 COURT ST
15 HIGHWAY 46
16 CENTER ST
17 PROPOSED I-675



NOTES

Reference numbers taken from the, "The Port of Detroit and ports on The Saginaw River, Michigan", Port Series No.46 Dated 1961
Project depths are referred to International Great Lakes Datum(1955) for Lake Huron, Elevation 576.8 ft. above Mean Water Level (M.W.L.) at Father Point,
Hachured areas denote work authorized but not constructed.

- (●) Indicates State Routes
- (US) Indicates U.S. Routes
- (I-75) Indicates Interstate Routes
- ~~ Aerial Cables



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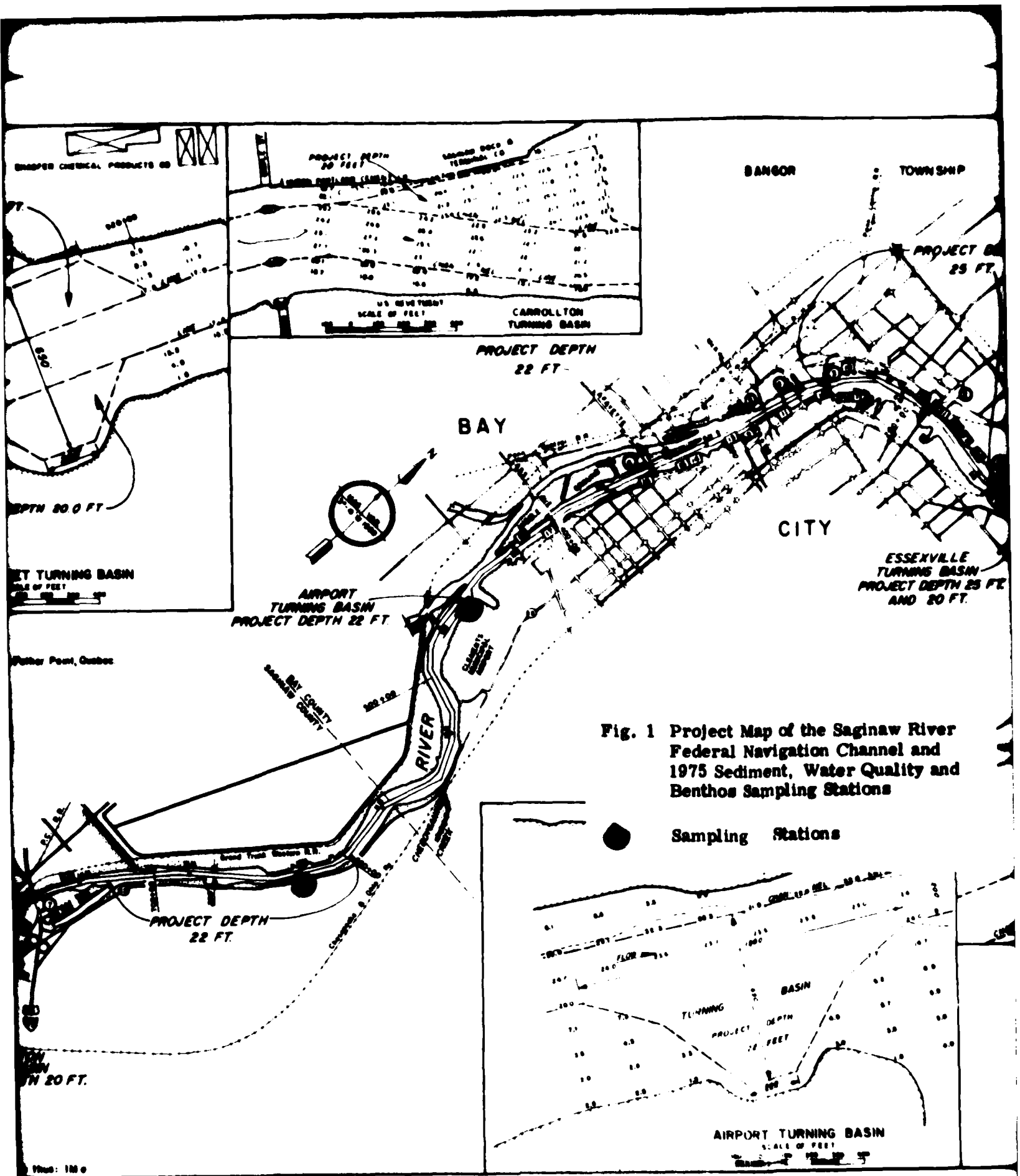


Fig. 1 Project Map of the Saginaw River Federal Navigation Channel and 1975 Sediment, Water Quality and Benthos Sampling Stations

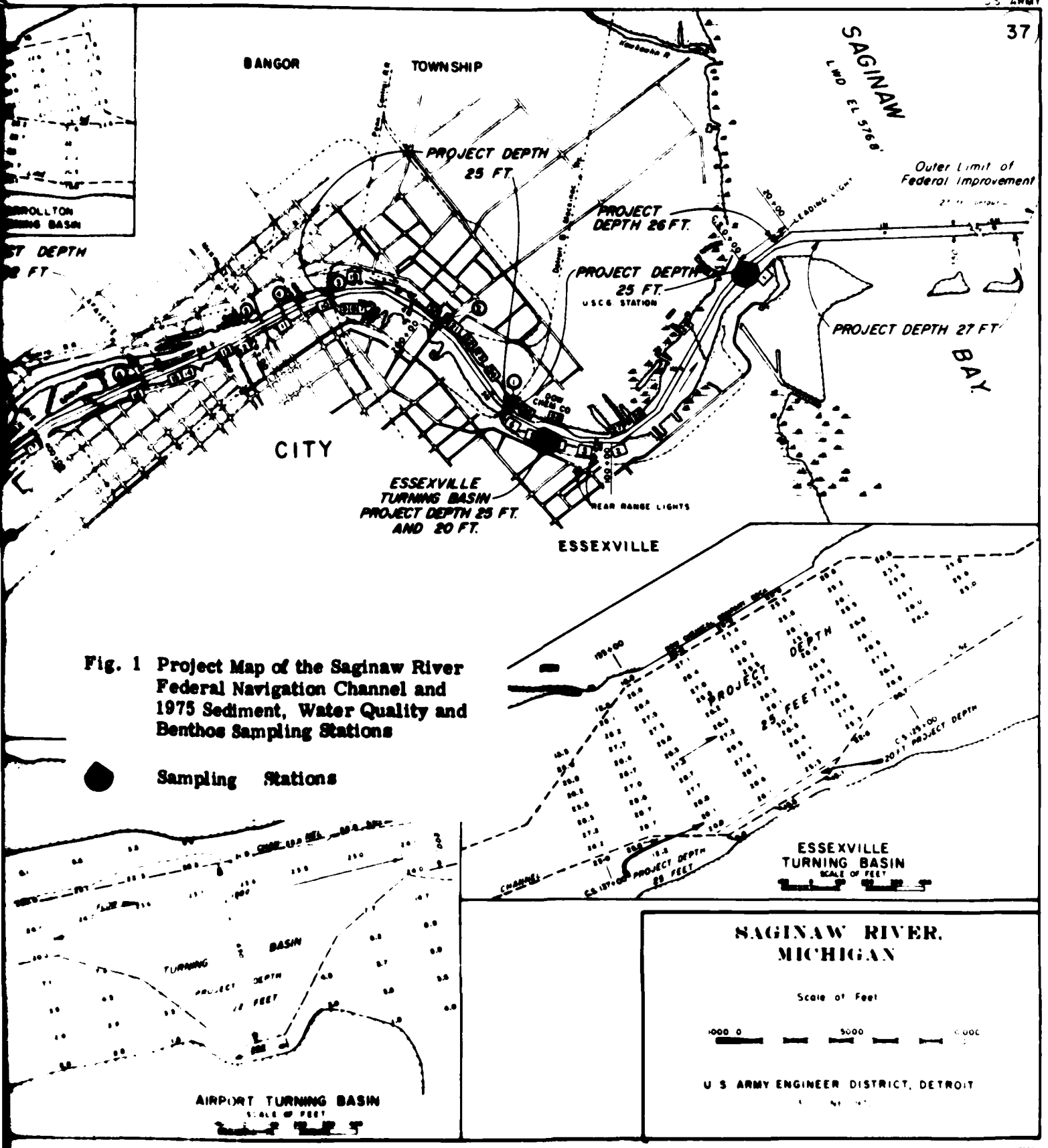


Fig. 1 Project Map of the Saginaw River Federal Navigation Channel and 1975 Sediment, Water Quality and Benthos Sampling Stations

● Sampling Stations

Figure 1

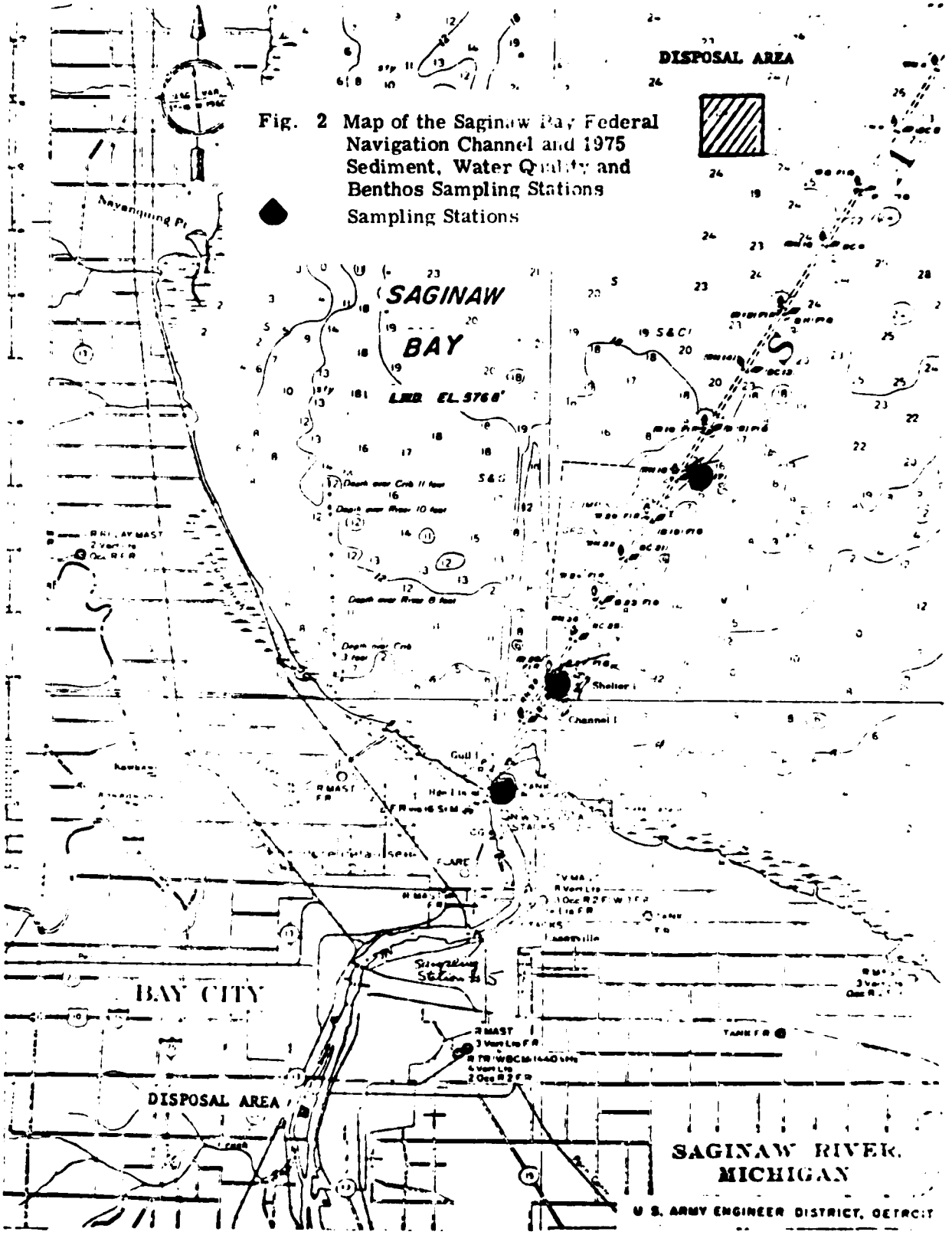
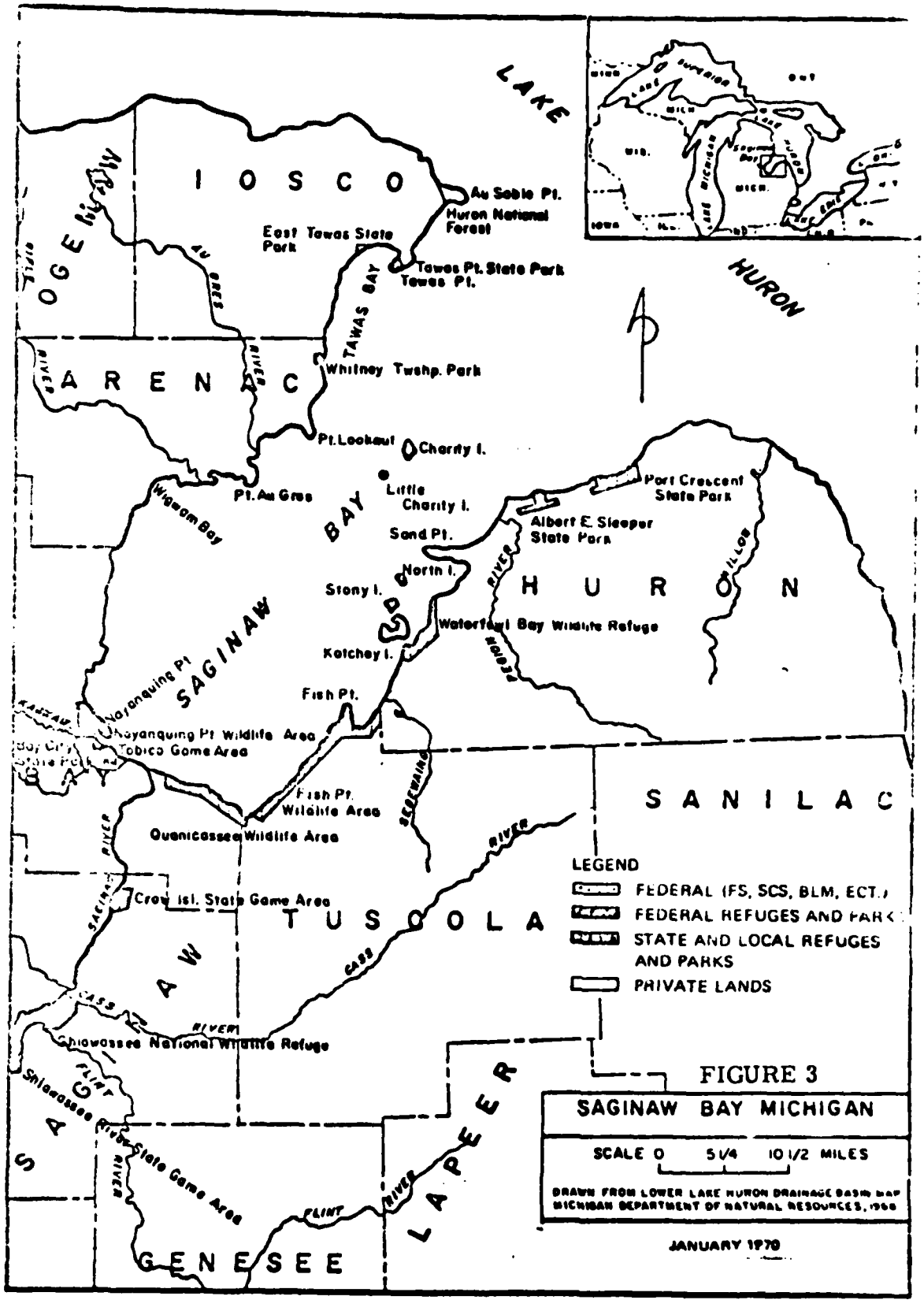


Fig. 2 Map of the Saginaw Bay Federal Navigation Channel and 1975 Sediment, Water Quality and Benthos Sampling Stations

● Sampling Stations

FIGURE 2


LAKE HURON
IOSCO
Au Sable Pt.
Huron National Forest
East Tawas State Park
Tawas Pt. State Park
Tawas Pt.
TAWAS BAY
Whitney Twshp. Park
Pt. Lookout
Charity I.
Little Charity I.
Pt. Au Gres
Wigwam Bay
BAY
Sand Pt.
North I.
Stony I.
Port Crescent State Park
Albert E. Sleeper State Park
HURON
Waterfowl Bay Wildlife Refuge
Ketchey I.
Fish Pt.
Nayanquing Pt
SAGINAW
Nayanquing Pt Wildlife Area
Tobico Game Area
Fish Pt. Wildlife Area
Quanicassee Wildlife Area
SANILAC
Crow Isl. State Game Area
TUSCOLA
SAGINAW
Shiawassee National Wildlife Refuge
Shiawassee River State Game Area
GENESEE
LAPEER
LEGEND
FEDERAL (FS, SCS, BLM, ECT.)
FEDERAL REFUGES AND PARKS
STATE AND LOCAL REFUGES AND PARKS
PRIVATE LANDS
FIGURE 3
SAGINAW BAY MICHIGAN
SCALE 0 5 1/4 10 1/2 MILES
DRAWN FROM LOWER LAKE HURON DRAINAGE BASIN MAP MICHIGAN DEPARTMENT OF NATURAL RESOURCES, 1968
JANUARY 1970

LAKE HURON

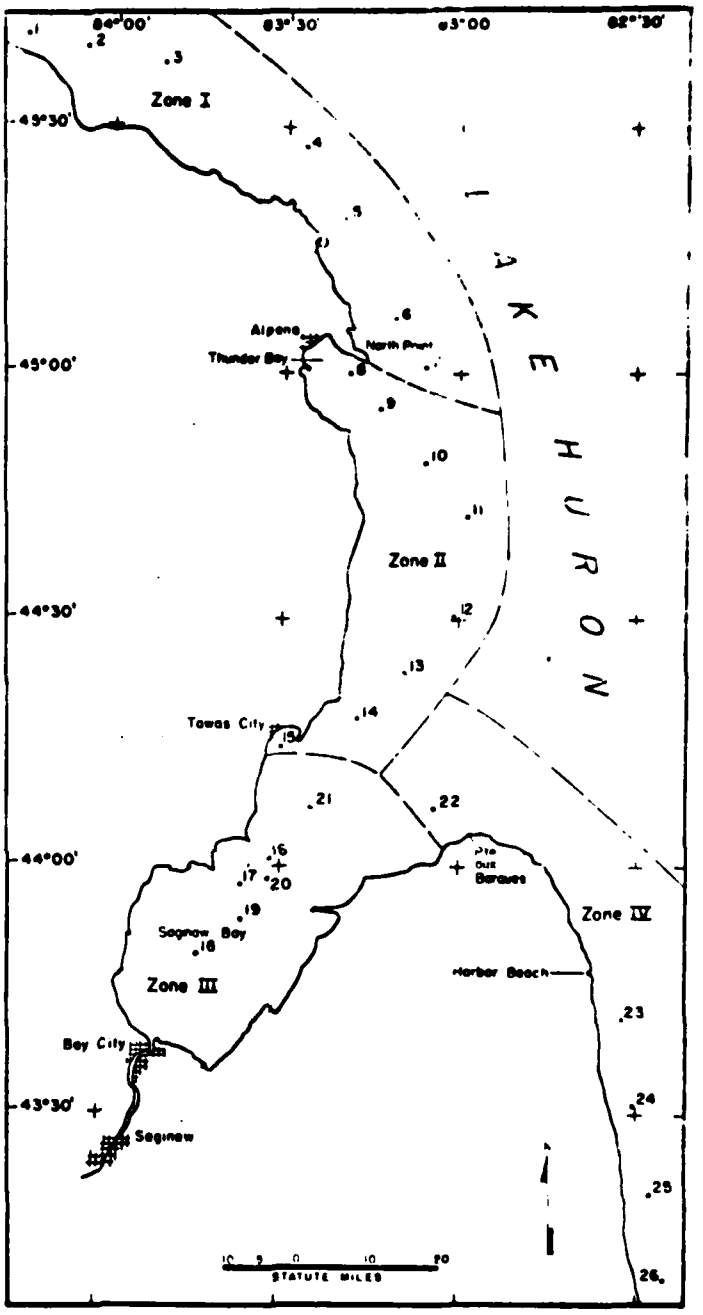


FIG. 4 Lake Huron sampling area showing locations of 4 zones and 26 stations.

(from Schelske and Roth, 1973)

FIGURE 4

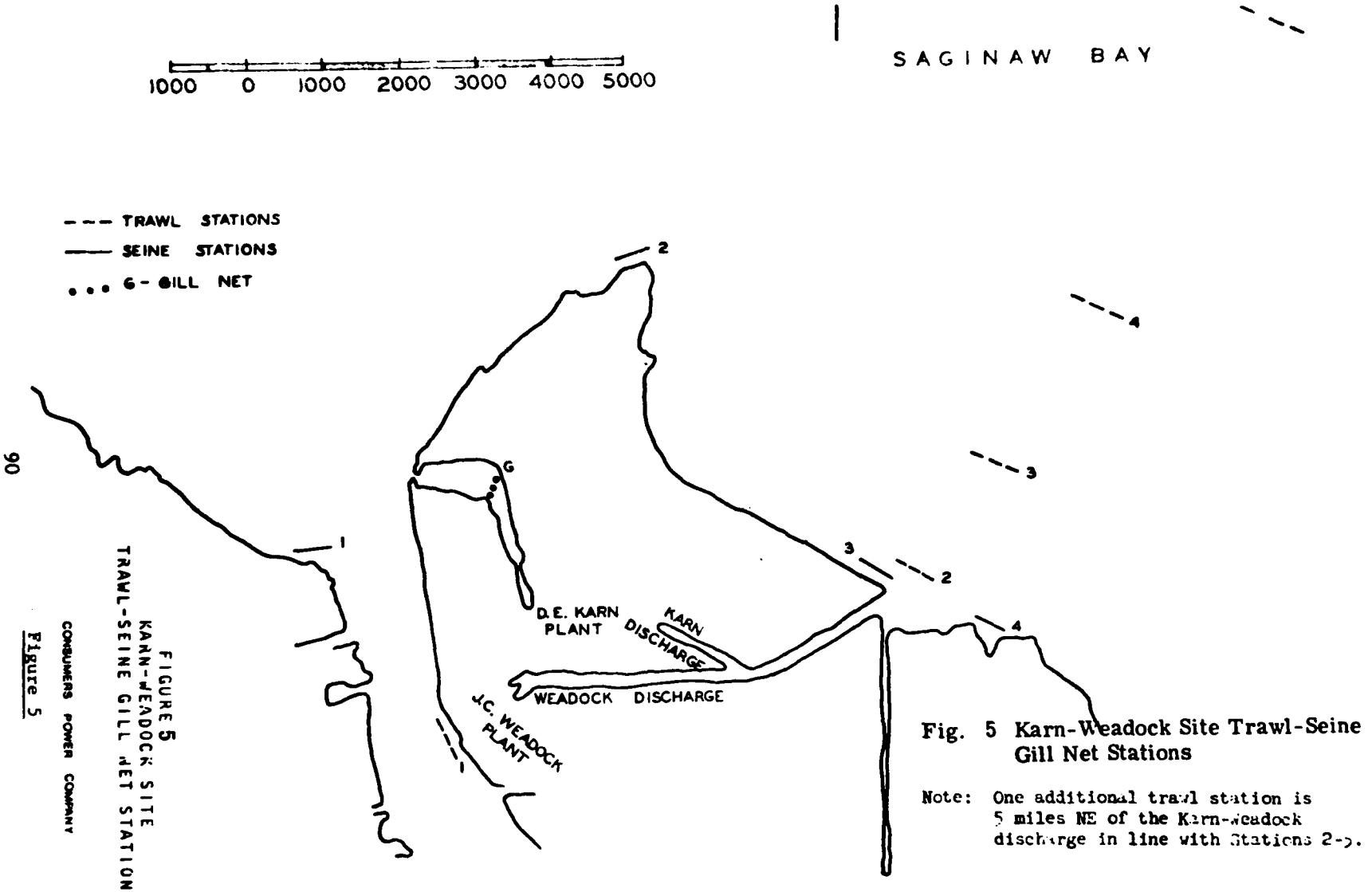


Fig. 5 Karn-Weadock Site Trawl-Seine Gill Net Stations

Note: One additional trawl station is 5 miles NE of the Karn-Weadock discharge in line with Stations 2-5.

FIGURE 5
KARN-WEADOCK SITE
TRAWL-SEINE GILL NET STATIONS

CONSUMERS POWER COMPANY

Figure 5

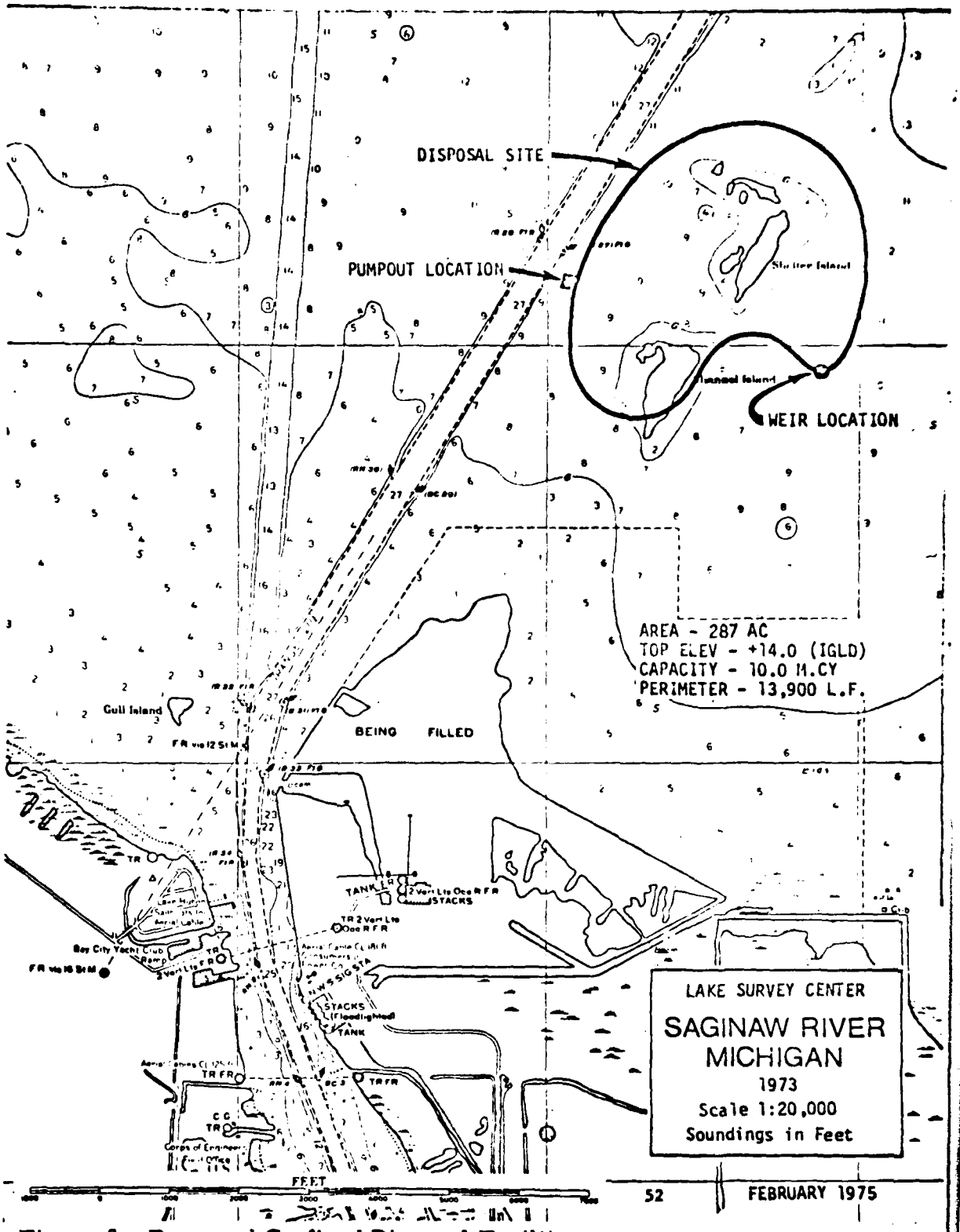


Figure 6. Proposed Confined Disposal Facility.

Figure 6

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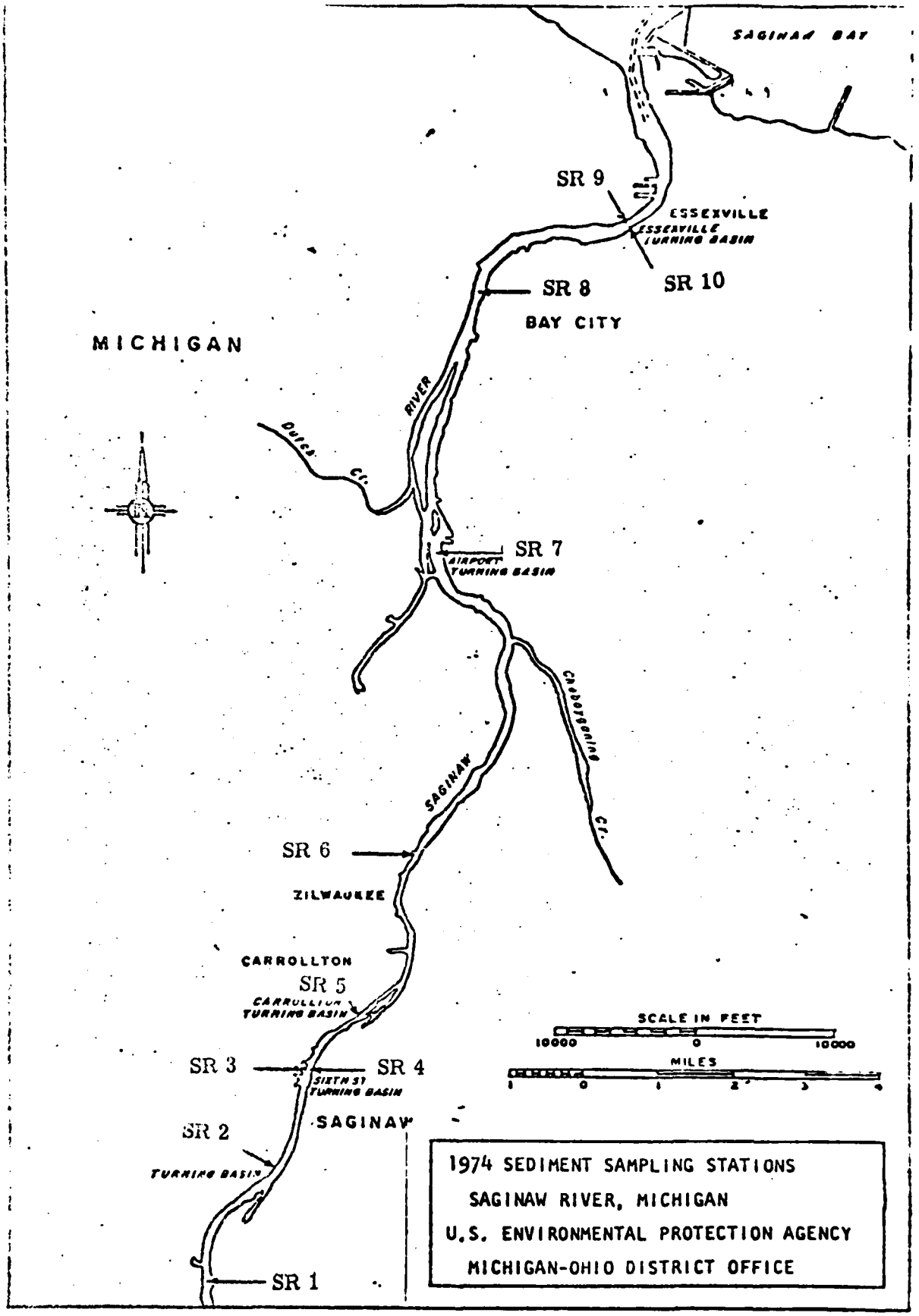
APPENDIX A

1974 SEDIMENT SAMPLE ANALYSIS AND BENTHOS DATA FROM SAGINAW RIVER AND SAGINAW BAY

U. S. ENVIRONMENTAL PROTECTION AGENCY


SAGINAW BAY
SR 9
ESSEXVILLE
ESSEXVILLE TURNING BASIN
SR 10
SR 8
BAY CITY
MICHIGAN
RIVER
Quiea Cr.
SR 7
AIRPORT TURNING BASIN
Chesaning Cr.
SAGINAW
SR 6
ZILWAUKEE
CARROLLTON
SR 5
CARROLLTON TURNING BASIN
SCALE IN FEET
10000 0 10000
MILES
1 0 1 2 3 4
SR 3
SR 4
SIXTH ST. TURNING BASIN
SAGINAW
SR 2
TURNING BASIN
SR 1
1974 SEDIMENT SAMPLING STATIONS
SAGINAW RIVER, MICHIGAN
U.S. ENVIRONMENTAL PROTECTION AGENCY
MICHIGAN-OHIO DISTRICT OFFICE

FIELD REPORT

CHANNEL: Saginaw River

STATE: Michigan

SAMPLED: June 4, 1974

SAMPLE & STATION NO.	LOCATION	DEPTH FEET	OBSERVATIONS
74-9568 SR-10	Essexville turning basin E. side of river 75' from shore	27'	Ekman grab, 70% silt, 10% sand 1/25", color grey-brown, 5% clam shell, 15% wood fibres chips
74-9569 SR-9	Essexville turning basin 100' from the west shore	30'	Ekman grab, 75% silt, 5% clay, 20% wood chips-fibres & leaves, color-grey
74-9570 SR-8	West side of channel north of Midland Street bridge	28'	Ekman grab, 60% silt, 15% sand 1/25", 25% wood chips & fibres, clam shells, color-grey, trace of oil.
74-9571 SR-7	Airport turning basin between RM-28 &BC-27	26'	Ekman grab, 70% sand 1/25", 10% silt, 20% wood chips & fibres, trace of oil, color grey, clam shells
74-9572 SR-6	Between RM-66 & BC-65	27'	Peterson dredge, 70% clay, 15% sand 1/25", 15% wood chips & fibres, Color-grey, trace of oil, clam and snail shells.
74-9573 SR-5	Carrollton turning basin 100' S.W. of RM-76	24'	Ekman grab, 70% sand 1/25", 10% silt, 20% wood chips & fibres. Trace of oil, clam & snail shells, color-grey.
74-9574 SR-3	Sixth Street turning basin west side of river 50' east of RM-80.	22'	Ekman grab, 75% sand 1/25", 10% silt, 15% woodchips & fibres, leaves & twigs, trace of oil, color-grey-brown, clam & snail shells
74-9575 SR-4	Sixth Street turning basin 100' from east shore	20'	Ekman grab, 80% sand 1/25", 15% wood chips, fibres, leaves & twigs, 5% silt, color-grey-brown, trace of oil, clam and snail shells.

SEDIMENT EVALUATION

CHANNEL: Saginaw River

STATE: Michigan

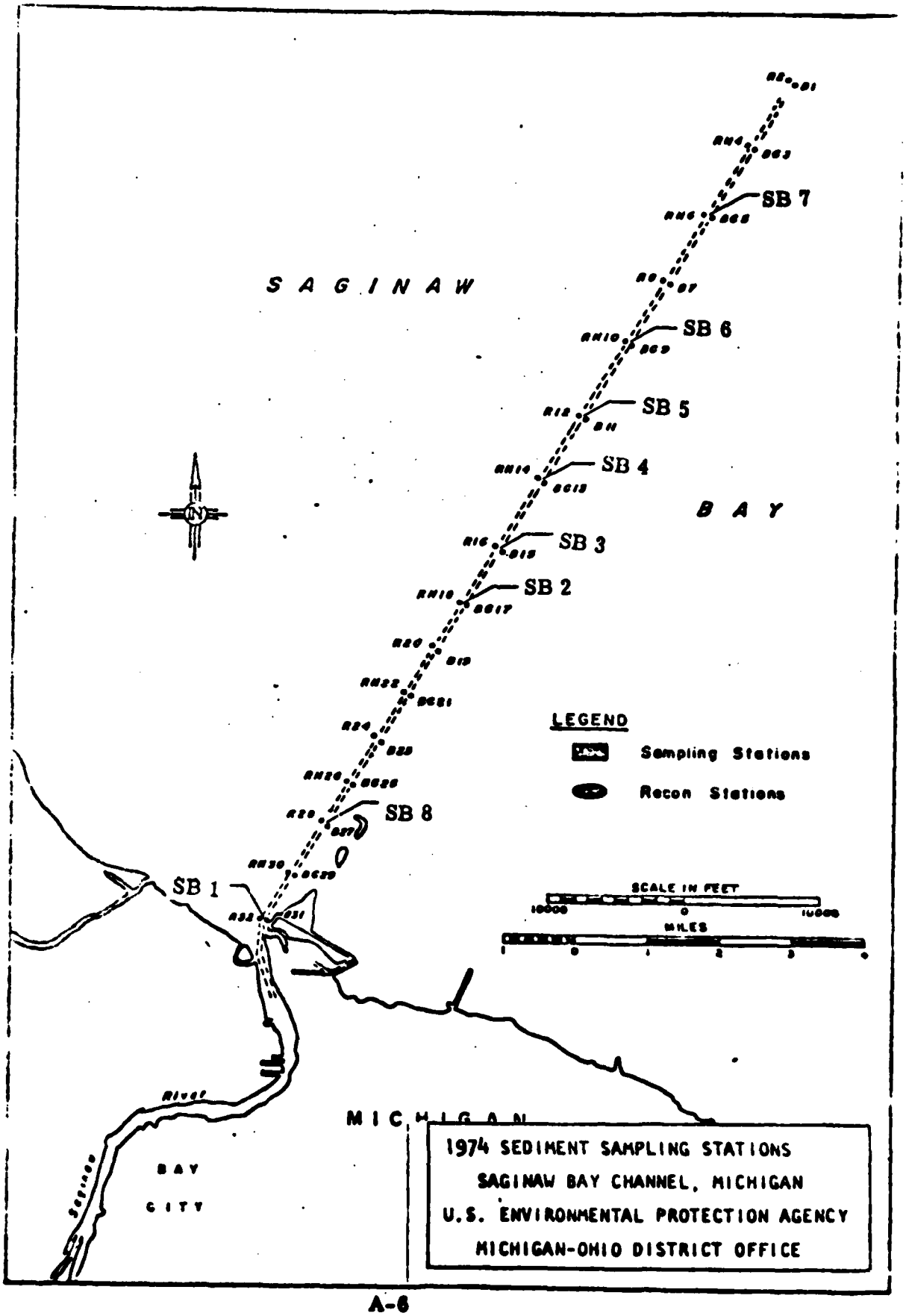
SAMPLED: June 4, 1974

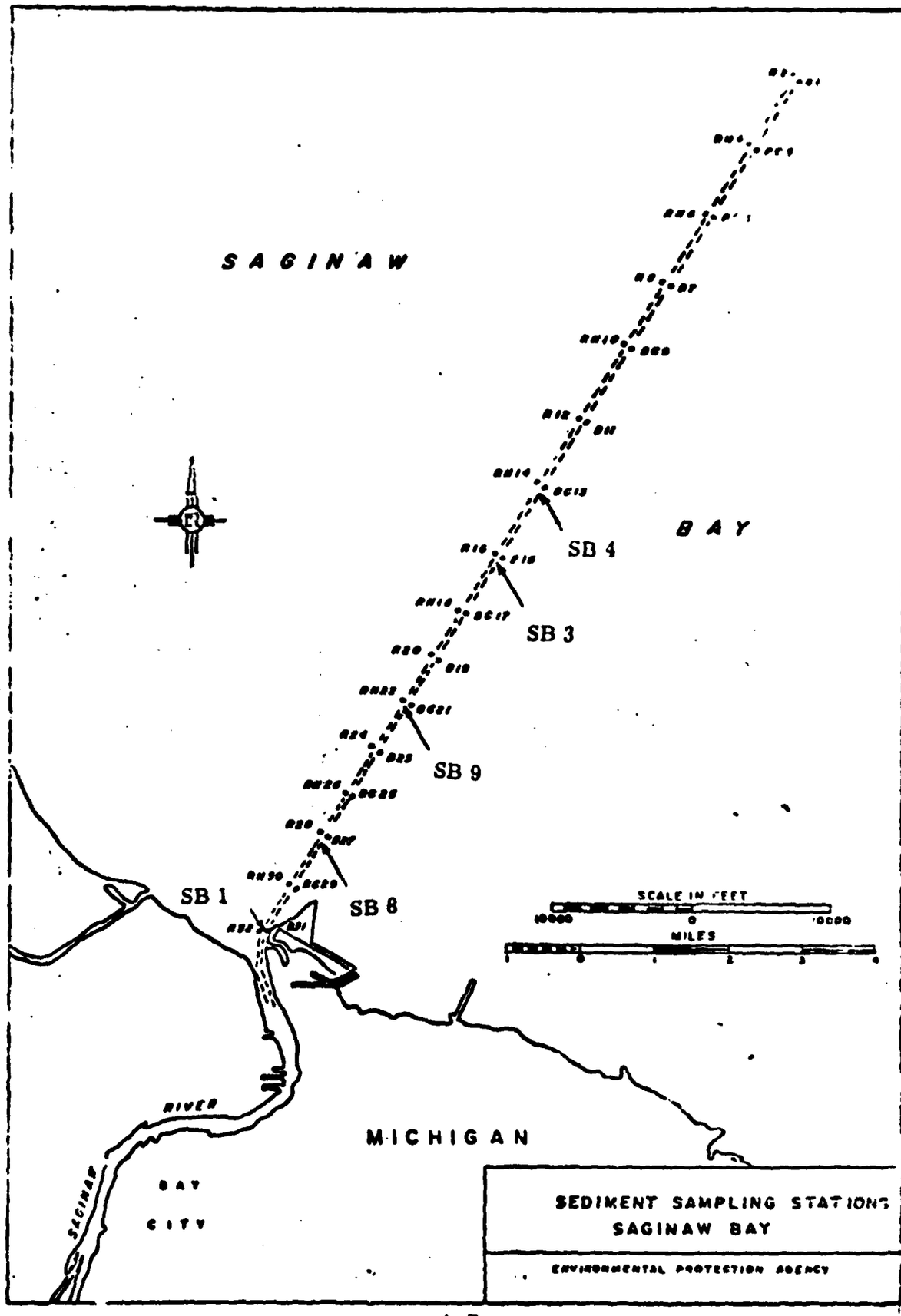
EVALUATING PARAMETER	MAX. ACCEPTABLE VALUES %	VALUES AT EACH STATION AS A PER CENT OF DRY WEIGHT							
		SR-10	SR-9	SR-8	SR-7	SR-6	SR-5	**-3	SR-4
Volatile Solids	6.0	5.89	8.79	7.62	6.17	6.23	6.36	6.57	3.47
Chemical Oxy. Demand	5.0	4.5	4.7	4.0	3.0	3.1	3.3	3.2	2.1
Tot. Kjel Nitrogen	0.10	0.18	0.25	0.21	0.15	0.14	0.16	0.14	0.05
Oil-Grease	0.15	0.33	0.70	0.35	0.26	0.07	0.30	0.37	0.04
Mercury	0.0001	0.00002	0.00003	0.00002	0.00002	0.00002	0.00002	0.00002	<0.00002
Lead	0.005	0.002	0.006	0.002	0.002	<0.001	0.004	0.002	0.002
Zinc	0.005	0.025	0.044	0.018	0.020	0.007	0.022	0.021	0.010
Manganese	None Available	0.034	0.051	0.030	0.039	0.035	0.035	0.027	0.015
Nickel	"	0.013	0.020	0.019	0.043	0.014	0.014	0.016	0.005
Total Phosphorus	"	0.110	0.094	0.130	0.082	0.048	0.084	0.023	0.024
Arsenic	"	0.0004	0.0007	0.0004	0.0006	0.0002	0.0005	0.0002	0.0004
Barium	"	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Cadmium	"	0.00073	0.00084	0.00087	0.00072	0.00056	0.00075	0.00052	0.00038
Chromium	"	0.0079	0.0100	0.0061	0.0070	0.0026	0.0042	0.0043	0.0039
Cobalt	"	0.0027	0.0027	0.0026	0.0029	0.0023	0.0022	0.0018	0.0016
Copper	"	0.0027	0.0082	0.0020	0.0011	0.0023	0.0027	0.0023	0.0014
Iron	"	1.50	2.20	1.20	1.50	1.40	1.20	1.10	0.65

SABINAV RIVER MACROINVERTEBRATES

6/4/74

DIPTERA	SR-3	SR-4	SR-5	SR-6	SR-7	SR-8	SR-9	SR-10
Procladius sp.	3	1		1	5		5	
OLIGOCHAETA								
Limnodrilus sp.	66	42	29	7	39	41	32	144
Tubifex sp.					1			
Peloscolex multisetosus								2
CLADOCERA								
Bosmina longirostris					2			
AMPHIPODA								
Gammarus fasciatus	1	1						
OTHER								
Cyclops vernalis								


SAGINAW
BAY
SB 1
SB 2
SB 3
SB 4
SB 5
SB 6
SB 7
SB 8
LEGEND
Sampling Stations
Recon Stations
SCALE IN FEET
10000
0
10000
MILES
0
1
2
3
4
MICHIGAN
BAY
CITY
1974 SEDIMENT SAMPLING STATIONS
SAGINAW BAY CHANNEL, MICHIGAN
U.S. ENVIRONMENTAL PROTECTION AGENCY
MICHIGAN-OHIO DISTRICT OFFICE


SAGINAW
BAY
SB 4
SB 3
SB 9
SB 1
SB 8
SCALE IN FEET
10000 0 10000
MILES
0 1 2 3
SAGINAW RIVER
BAY CITY
MICHIGAN
SEDIMENT SAMPLING STATIONS
SAGINAW BAY
ENVIRONMENTAL PROTECTION AGENCY

FIELD REPORT

CHANNEL: Saginaw Bay

STATE: Michigan

SAMPLED: June 3, 1974

SAMPLE & STATION NO.	LOCATION	DEPTH FEET	OBSERVATIONS
74-9559 SB-7	Approx. 12.3 miles N.E. of the mouth of the Saginaw River center of channel	32'	Petersen dredge, 95% silt, 5% clay, color grey
74-9560 SB-6	Approx. 10 miles N.E. of the mouth of the Saginaw River. Center of the channel	32'	Ekman grab, 100% silt, color-grey, bloodworms, sludgeworms.
74-9561 SB-5	Approx. 8.5 miles N.E. of the mouth of the Saginaw River center of channel	30'	Ekman grab, 60% silt, 10% sand 1/25", 10% clay, color grey-brown, Bloodworms.
74-9562 SB-4	Approx. 7.6 miles N.E. of the mouth of the Saginaw River. Center of channel.	32'	Ekman grab, 100% silt, color-grey-brown, trace of oil, bloodworms & sludgeworms.
74-9563 SB-3	Approx. 6.6 miles N.E. of the mouth of the Saginaw River, center of the channel.	32'	Ekman grab, 95% silt, 5% clay, trace of oil, color-grey, blood-worms, sludgeworms.
74-9564 SB-2	Approx. 5.7 miles N.E. of the mouth of the Saginaw River. Center of the channel.	32'	Ekman grab, 100% silt, color-grey, trace of oil, sludgeworms.
74-9565 SB-9	Approx. 4.0 miles N.E. of the mouth of the Saginaw River. Center of the channel	30'	Ekman grab, 100% silt, color-grey, trace of oil, bloodworms, sludge-worms.
74-9566 SB-8	Approx. 1.9 miles N.E. of the mouth of the Saginaw River. Center of the channel	29'	Ekman grab, 100% silt, color-grey, trace of oil, sludgeworms.
74-9567 SB-1	Approx. 0.5 miles N.E. of the mouth of the Saginaw River. Center of the channel.	28'	Ekman grab, 90% silt, 10% leaves & twigs, color-grey, trace of oil, sludgeworms.

SEDIMENT EVALUATION

CHANNEL: Saginaw Bay

STATE: Michigan

SAMPLED: June 3, 1974

EVALUATING PARAMETER	MAX. ACCEPTABLE VALUES %	VALUE AT EACH STATION AS A PER CENT OF DRY WEIGHT								
		SB-7	SB-6	SB-5	SB-4	SB-3	SB-2	SB-9	SB-8	SB-1
Volatile Solids	6.0	9.8	12.6	4.5	11.6	11.5	12.5	11.5	12.7	11.7
Chemical Oxy. Demand	5.0	8.7	12.0	3.8	12.0	12.0	12.0	11.0	14.0	12.0
Tot. Kjel. Nitrogen	0.10	0.130	0.120	0.063	0.120	0.130	0.140	0.140	0.130	0.150
Oil-Grease	0.15	0.096	<0.020	0.100	0.180	0.180	0.200	0.250	0.710	0.230
Mercury	0.0001	<0.00004	<0.00005	<0.00003	<0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00003
Lead	0.005	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.005	0.005
Zinc	0.005	0.017	0.021	0.008	0.020	0.006	0.021	0.022	0.045	0.055
Manganese	None Available	0.051	0.058	0.033	0.052	0.048	0.051	0.050	0.055	0.059
Nickel	"	0.027	0.030	0.012	0.029	0.0070	0.023	0.023	0.029	0.024
Total Phosphorus	"	0.065	0.072	0.033	0.075	0.073	0.085	0.084	0.150	0.160
Arsenic	"	0.0007	0.0005	0.0002	0.0004	0.0004	0.0008	<0.0004	0.0007	0.0005
Barium	"	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060	<0.0060
Cadmium	"	0.00093	0.0012	0.00021	0.0013	<0.00006	0.0011	0.00084	0.0017	0.0011
Chromium	"	0.0077	0.0073	0.0058	0.0070	0.0052	0.0084	0.0080	0.0091	0.0110
Cobalt	"	0.0044	0.0037	0.0022	0.0052	<0.0015	0.0040	0.0031	0.0042	0.0033
Copper	"	0.0010	0.0013	<0.0003	<0.0005	<0.0004	0.0013	0.0009	0.0036	0.0062
Iron	"	2.2	2.4	1.2	2.3	1.6	2.2	2.2	3.0	3.2

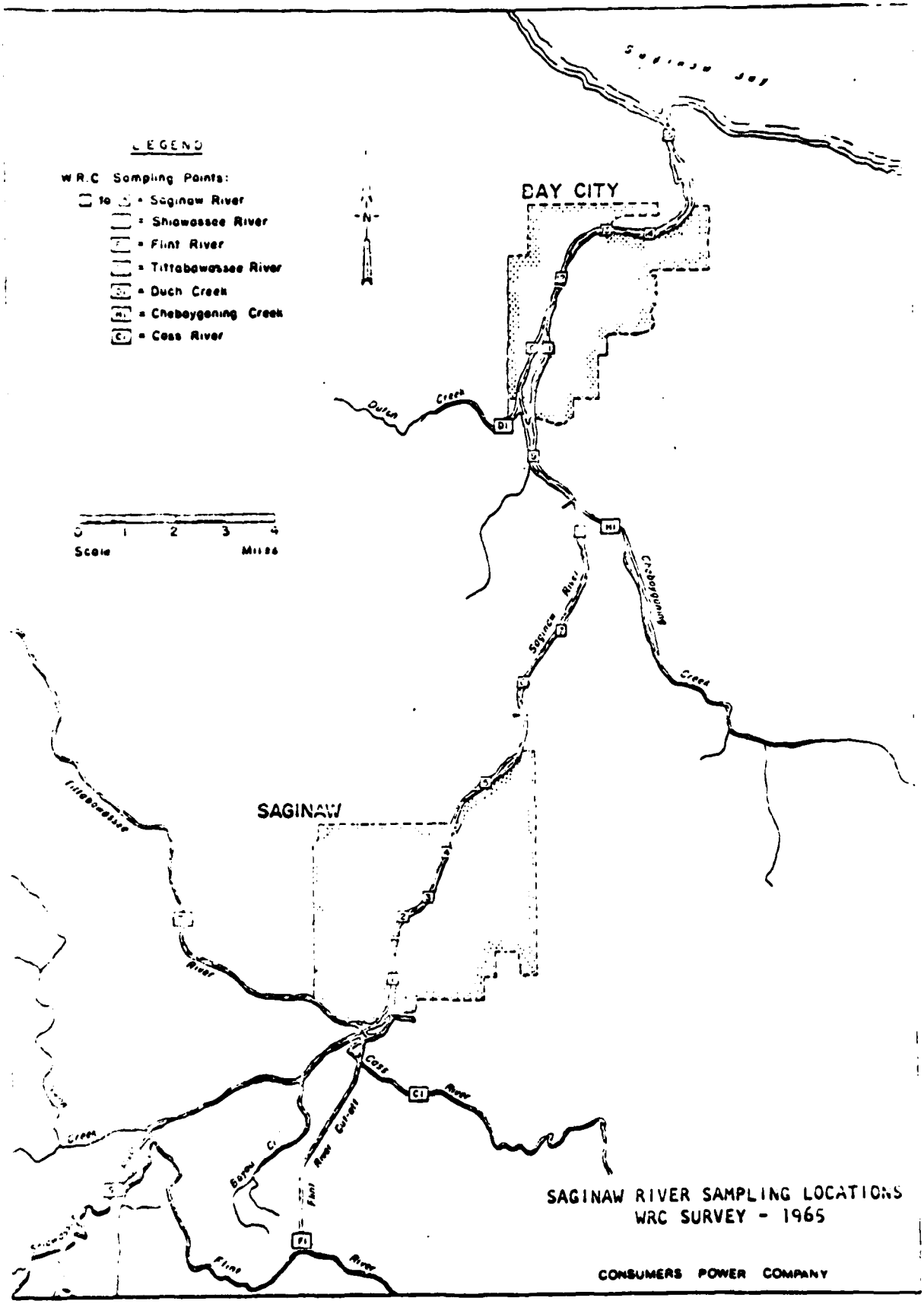
SAGINAW BAY MACROINVERTEBRATES

6/3/74

DIPTERA	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7	SB-8	SB-9
Ceratopogonidae	4								
Procladius sp.	12	46	27	10	3	14		36	57
Chironomini			2						1
Chironomus sp.				1	8	4			4
Chironomidae						2			
OLIGOCHAETA									
Tubifex sp.	8	16	20	10	8	124	7	1	3
Limnodrilus sp.	228	325	327	349	160	1175	51	125	180
Peloscolex multisetosus		5	7	5	3	1			
CLADOCERA									
Eurycercus lamellatus						24			
COPEPODA									
Cyclopidae			1						
Cyclops vernalis					1				
Mesdcyclops edax						16			

APPENDIX B

WATER QUALITY DATA FOR SAGINAW BAY AND SAGINAW RIVER. STATE OF MICHIGAN WATER RESOURCES COMMISSION. DOW CHEMICAL COMPANY, CONSUMERS POWER COMPANY, AND UNITED STATES ENVIRONMENTAL PROTECTION AGENCY


LEGEND
W.R.C. Sampling Points:
D1 to C1 = Saginaw River
= Shiawassee River
= Flint River
= Tittabawassee River
= Duch Creek
= Cheboygening Creek
= Cass River
N
BAY CITY
SAGINAW
Scale
Miles
SAGINAW RIVER SAMPLING LOCATIONS
WRC SURVEY - 1965
CONSUMERS POWER COMPANY

SAGINAW RIVER
Composite River Samples

October 26 and 27, 1965

The following are the laboratory analyses of a composite sample for each station made up from six individual samples collected during the first 24 hours of the survey:

Station Location	NO_3	NO_2	NH_3-N	PO_4	Total PO_4	AD	pH	Fe	Cr^6	COD	SO_4	Phenol	CN	Cl	HCO_3	Suspended Solids	Suspended Volatile Solids	Conductivity
D1	.0	.00	1.0	.0		.1	7.2	1.1	.00	88	95	.006	.00	230	280	42	27	1200
T1	1.8	.03	.0	.25		.1	7.8	.4	.00	23	70	.006	.00	260	210	18	11	1200
S1	1.5	.05	.0	.75		.1	7.6	.7	.00	33	92	.004	.00	56	310	26	12	710
C1	1.5	.08	.0	.56		.2	8.0	.9	.00	17	97	.000	.00	85	265	24	10	750
F1	20.0	.75	1.0	8.2		.3	7.9	.1	.00	22	120	.000	.00	105	190	4	4	820
H1	2.4	.07	.3	.85		.2	7.8	.6	.00	28	72	.000	.00	200	220	24	11	1100
X1	3.4	.10	.3	.80		.2	7.9	.5	.00	26	89	.006	.00	270	230	15	9	1200
X2	3.9	.10	.4	1.0		.2	7.9	.4	.00	22	82	.004	.00	270	225	13	7	1250
X3	3.0	.08	.4	.7		.2	7.9	.4	.00	20	84	.004	.00	285	230	12	10	1300
X4	3.3	.08	.4	1.0		.2	7.9	.4	.00	21	98	.003	.00	280	235	11	8	1300
X5	3.6	.10	.4	1.2		.2	7.8	.4	.00	21	89	.004	.00	275	235	15	10	1300
X6	3.0	.11	.4	1.3		.2	7.8	.5	.00	25	84	.004	.00	225	225	16	8	1200
X7	2.8	.08	.4	1.1		.2	7.7	.4	.00	28	78	.004	.00	225	225	18	11	1150
X8	2.7	.06	.4	.85		.2	7.7	.5	.00	28	80	.004	.00	210	220	14	9	1100
X9	2.6	.05	.4	.70		.2	7.7	.4	.00	28	82	.004	.00	210	215	19	9	1100
X10	2.4	.06	.4	.70		.2	7.7	.4	.00	25	80	.004	.00	220	215	17	9	1100
X11	1.7	.08	.5	.47		.2	7.6	.4	.00	26	83	.002	.00	230	225	13	10	1200
X12	2.4	.06	.4	.62		.2	7.7	.4	.00	22	78	.004	.00	225	215	15	9	1100
X13	2.4	.08	.5	.65		.2	7.7	.3	.00	21	75	.004	.00	230	210	15	9	1100
X14	2.2	.08	.3	.60		.2	7.7	.3	.00	20	75	.002	.00	225	205	14	9	1100
X15	1.7	.08	.5	.44		.2	7.8	.2	.00	17	64	.002	.00	170	170	15	10	890

Note: All the above values except pH and conductivity are expressed as mg/l.
Conductivity is expressed as micro-MHOS.

Sampled by: Michigan Water Resources Commission
US Public Health Service

SAGINAW RIVER
Composite Water Sampling

July 20 and 21, 1965

The following are the laboratory analyses of a composite sample for each station made up from six individual samples collected during the first 24 hours of the survey.

Station Location	NO_3	NO_2	NH_3-N	PO_4	Total PO_4	Al	pH	Fe	Cr^{+6}	COD	Filtered COD	Phenol	CN	Cl	Filtered* 14-Day BOD	Suspended Solids	Suspended Volatile Solids	Conductivity
D1	.3	.00	.0	.1		.1	8.1	3.3	.00	80		.00	.00	460	2.9	197	61	1700
T1	.3	.04	1.8	.3		.2	7.7	.8	.00	45		.01	.00	575	---	19	8	2000
S1	.7	.00	.0	1.1		.2	8.4	1.4	.00	42		.00	.00	80	3.2	76	23	750
C1	.3	.00	.0	.4		.1	8.3	1.1	.00	35		.00	.00	110	3.8	49	18	890
F1	12.0	.09	.0	9.6		.3	8.3	.7	.00	31		.00	.00	105	3.0	33	13	910
H1	1.0	.21	.7	.9		.3	8.0	.5	.00	50	26	.00	.00	420	3.0	36	19	165
X1	1.6	.07	.3	1.2	2.0	.2	8.3	.9	.00	38	30	.00	.00	255	2.5	37	12	1420
X2	1.3	.05	.2	.9	1.8	.2	8.2	.8	.00	42	32	.00	.00	380	2.8	38	16	1500
X3	1.6	.05	.4	.8	1.8	.2	8.0	.8	.00	38	28	.00	.00	400	3.6	36	15	1600
X4	1.0	.05	.6	.7	1.2	.2	7.8	.7	.00	40	31	.01	.00	490	2.8	39	17	1780
X5	1.0	.08	.9	.5	1.2	.2	7.7	.7	.00	38	28	.00	.00	485	4.0	28	11	1820
X6	1.0	.14	1.3	1.0	2.2	.2	7.8	.5	.00	42	26	.00	.00	480	4.0	28	14	1800
X7	1.0	.17	1.2	1.0	1.7	.2	7.8	.4	.00	38	26	.00	.00	455	4.2	26	15	1750
X8	1.0	.25	.8	1.0	1.5	.2	8.0	.5	.00	48	25	.00	.00	420	3.5	33	20	1650
X9	1.0	.19	.2	.6		.2	8.3	.6	.00	45	27	.00	.00	435	3.1	43	24	1680
X10	1.3	.18	.1	.4		.2	8.2	.7	.00	46	26	.00	.00	445	4.2	42	22	1720
X11	1.1	.16	.0	.4		.3	8.3	.8	.00	49	25	.00	.00	450	3.1	55	26	1800
X12	1.4	.17	.1	.5	1.4	.2	8.1	.8	.03	41	25	.00	.00	455	2.7	38	20	1780
X13	1.0	.17	.5	.6	1.4	.2	8.0	.8	.03	46	29	.00	.00	425	3.0	42	19	1700
X14	1.0	.13	.7	.7		.2	7.9	.6	.00	44	28	.00	.00	405	2.5	31	16	1600
X15	.5	.05	.1	.2		.1	8.1	.5	.00	33	21	.00	.00	220	2.9	31	16	990

Note: All concentrations except pH and conductivity are expressed as mg/l. Conductivity is expressed as micro-MHOS.

*14-day BODs were corrected for nitrification.

Sampled by: Michigan Water Resources Commission
US Public Health Service

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of June 9, 1970

Sample	Location	Chloride mg/l Cl^-	Total Alkalinity mg/l $CaCO_3$	Total Hardness mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth - Buoy No 32	130	190	266	7.6	74
B	Channel - Buoy No 24	46	117	152	8.0	70
C	Old Bay City Water Intake	39	111	140	8.0	68
D	New Bay City Water Intake	39	109	137	8.0	64
E	Channel - Buoy No 16	36	108	131	8.3	72
F	Off Quanicassee	43	101	135	8.0	73
G	Off Fish Point	36	100	130	8.3	74
H	Channel - 10.5 Mi From River Mouth	28	100	124	8.4	71
I	Off Pinconning Bar	36	108	131	8.0	68
J	Off Saganing Bar	28	102	115	8.1	69
K	Channel - 16 Miles From River Mouth	21	97	105	8.3	70
L	Off South Mineshas Island	50	114	140	8.1	70
M	Off North Island	32	95	120	8.3	72
N	Off Point AuGres	18	96	109	8.4	72
O	East of Point AuGres - 3.25 Miles	18	96	112	8.4	69
P	Off Caseville	18	91	109	8.2	70
Q	Off Oak Point	18	90	102	8.3	70
R	Bell Off Whitestone Point	14	90	100	8.[illegible]	[illegible]
S	Over Whitestone Intake	11	90	9[illegible]	[illegible]	64
T	Off Tawas City	4	89	89	[illegible]	[illegible]

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of August 11, 1970

Sample	Location	Chloride mg/l Cl	Total Alkalinity mg/l $CaCO_3$	Total Hardness mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth - Buoy No 32	60	110	134	8.1	82
B	Channel - Buoy No 24	32	93	102	7.7	79
C	Old Bay City Water Intake	57	99	129	7.7	80
D	New Bay City Water Intake	25	95	96	8.1	78
E	Channel - Buoy No 16	28	93	98	8.1	79
F	Off Quanicassee	46	83	107	8.1	78
G	Off Fish Point	32	87	96	8.3	78
H	Channel - 10.5 Miles From River Mouth	21	98	100	8.2	78
I	Off Pinconning Bar	21	98	96	8.4	78
J	Off Saganing Bar	21	99	91	8.4	78
K	Channel - 16 Miles From River Mouth	21	97	98	8.4	78
L	Off South Mineshas Island	46	81	103	8.2	78
M	Off North Island	21	92	93	8.4	76
N	Off Point AuGres	21	97	95	8.5	76
O	East of Point AuGres - 3.25 Miles	21	97	96	8.4	75
P	Off Caseville	18	90	89	8.4	73
Q	Off Oak Point	14	89	86	8.4	71
R	Bell Off Whitestone Point	18	91	89	8.4	74
S	Over Whitestone Intake	18	92	88	8.4	74
T	Off Tawas City	11	87	80	8.4	74

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of September 30 and October 1, 1970

Sample	Location	Chloride mg/l Cl^-	Total Alkalinity mg/l $CaCO_3$	Total Hardness mg/l $CaCO_3$	pH	Temp ^oF
A	Saginaw River Mouth	120	193	300	8.1	60
B	R24 Buoy (in Channel)	18	93	104	8.5	58
C	Near Old Bay City Water Intake	14	88	96	8.2	58
D	Over New Bay City Water Intake	14	87	93	8.5	58
E	R16 Buoy (in Channel)	11	85	93	8.4	58
F	Off Quanicassee	92	126	193	8.4	56
G	Off Fish Point	25	91	111	8.4	58
H	Off South Mineshas	18	83	104	8.4	58
I	Off North Island	11	90	95	8.5	57
J	At Buoy Off Sand Point	11	89	102	8.4	56
K	Off Caseville	28	92	114	8.4	56
L	Off Oak Point	11	86	91	8.4	57
M	At Bell Off Whitestone Point	4	77	80	8.5	55
N	Over Water Intake Off Whitestone Pt	4	78	71	8.4	56
O	Off Little Charity Island	11	83	91	8.4	56
P	Off Point AuGres	11	85	95	8.4	58
Q	Between Point AuGres and North Island	11	84	84	8.5	56
R	Between Saganing Bar and South Mineshas	11	88	96	8.5	56
S	Off Pinconning Bar	11	82	95	8.5	57

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay SURVEY OF AUGUST 4-5, 1971

Sample	Location	Chloride mg/l Cl^- 628	Chloride mg/l Cl^- 574	Total Alkalinity mg/l $CaCO_3$ 628	Total Alkalinity mg/l $CaCO_3$ 574	Total Hardness mg/l $CaCO_3$ 628	Total Hardness mg/l $CaCO_3$ 574**	pH 628	pH 574	Temp °F
A	Saginaw River Mouth	36	41	104	110	118	141	8.2		68
B	Channel - Buoy No 24	25	26	104	100	112	130	8.3		68
C	Old Bay City Water Intake	28	31	98	85	107	126	8.2		68
D	New Bay City Water Intake	25	24	107	96	110	130	8.4		68
E	Channel - Buoy No 16	23	24	103	98	107	127	8.3		68
F	Off Quanicassee	39	41	68	80	105	129	8.3		69
G	Off Fish Point	25	26	100	95	107	126	8.5		69
H	Channel - Buoy No 10	16	18	95	88	95	116	8.3		68
I	Off Pinconning Bar	21	24	104	95	108	130	8.4		69
J	Off Saganing Bar	25	26	104	94	109	132	8.5		68
K	Channel - 16 Miles From River Mouth	18	18	92	85	95	112	8.4		68
L	Off South Mineshas Island	27	28	94	86	103	126	8.5		69
M	Off North Island	32	34	89	80	103	124	8.5		69
N	Off Point AuGres	18	20	96	90	100	120	8.3		68
O	East of Point AuGres - 3.25 Miles	20	21	99	91	102	124	8.3		68
P	Off Caseville	18	24	91	85	96	118	8.4		66
Q	Off Oak Point	14	33*	92	85	93	112	8.5		66
R	Bell Off Whitestone Point	14	18	92	87	93	112	8.4		65
S	Over Whitestone Intake	14	17	91	85	93	112	8.5		65
T	Gravelly Shoal Light	21	23	100	95	103	126	8.3		67

*Chloride Result High
**Hardness [illegible] 20 [illegible] High

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of September 27, 1971

Sample	Location	Chloride mg/l Cl^-	Total Alkalinity mg/l $CaCO_3$	Total Hardness mg/l $CaCO_3$	Temp °F
A	Saginaw River Mouth	30	90	126	67
B	Channel - Buoy No 24	20	95	125	65
C	Old Bay City Water Intake	27	90	121	64
D	New Bay City Water Intake	41	92	130	64
E	Channel - Buoy No 16	16	93	116	64
F	Off Quanicassee	27	94	122	64
G	Off Fish Point	20	93	118	64
H	Channel - Buoy No 10	18	94	120	65
I	Off Pinconning Bar	27	91	118	63
J	Off Saganing Bar	23	93	123	63
K	Channel - 16 Miles From River Mouth	16	93	112	66
L	Off South Mineshas Island	20	92	110	66
M	Off North Island	16	92	114	66
N	Off Point AuGres	16	98	122	68
O	East of Point AuGres - 3.25 Miles	11	87	104	67
P	Off Caseville	12	89	110	67
Q	Off Oak Point	12	88	104	66
R	Bell Off Whitestone Point	11	85	100	67
S	Over Whitestone Intake	9	84	98	67
T	Off Tawas	11	85	100	64

DOW CHEMICAL CO. WATER QUALITY DATA
Saginaw Bay Survey of May 28, 1972

Sample	Location	Chloride mg/l Cl^-	Total Hardness mg/l $CaCO_3$	Total Alkalinity mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth	67	237	153	8.3	70
B	Channel - Buoy No 24	30	126	93	8.1	66
C	Old Bay City Water Intake	57	190	119	8.4	70
D	New Bay City Water Intake	27	131	92	8.1	67
E	Channel - Buoy No 16	25	122	93	8.3	65
F	Off Quanicassee	28	124	84	7.9	69
G	Off Fish Point	12	120	91	8.2	67
H	Channel - Buoy No 10	39	155	101	8.4	66
I	Off Pinconning Bar	32	126	94	8.2	67
J	Off Saginaw Bar	23	122	96	8.4	64
K	Channel - 16 Miles From River Mouth	34	145	101	8.3	66
L	Off South Mineshas Island	12	112	90	8.2	67
M	Off North Island	11	104	88	8.2	64
N	Off Point AuGres	25	124	97	8.4	65
O	East of Point AuGres - 3.25 Miles	21	126	97	8.3	64
P	Off Caseville	12	106	87	8.2	56
Q	Off Oak Point	11	98	86	8.2	58
R	Bell Off Whitestone Point	21	120	94	8.3	62
S	Over Whitestone Intake	20	118	94	8.4	62
T	Off Tawas	7	94	83	8.2	59

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of July 20, 1972

Sample	Location	Chloride mg/l Cl^-	Total Hardness mg/l $CaCO_3$	Total Alkalinity mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth	90.5	267	139	7.9	77
B	Channel - Buoy No 24	60.4	195	112	7.6	75
C	Old Bay City Water Intake	49.7	186	111	7.9	75
D	New Bay City Water Intake	28.4	155	100	7.8	79
E	Channel - Buoy No 16	23.1	139	100	8.2	73
F	Off Quanicassee	28.4	126	83	8.1	74
G	Off Fish Point	37.3	142	70	7.8	76
H	Channel - Buoy No 10	19.5	132	95	8.1	73
I	Off Pinconning Bar	24.9	155	98	7.9	75
J	Off Saginaw Bar	30.2	148	97	8.1	76
K	Channel - 16 Miles From River Mouth	21.3	135	97	8.4	74
L	Off South Mineshas Island	26.6	135	90	8.0	77
M	Off North Island	23.1	124	86	8.0	78
N	Off Point AuGres	26.6	148	98	8.2	77
O	East of Point AuGres - 3.25 Miles	23.1	144	99	8.1	76
P	Off Caseville	8.9	121	88	8.2	73
Q	Off Oak Point	8.9	117	87	8.1	73
R	Bell Off Whitestone Point	14.2	119	91	7.9	73
S	Over Whitestone Intake	14.2	112	88	8.1	73
T	Off Tawas	12.4	117	89	8.1	72

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of September 26, 1972

Sample	Location	Chloride mg/l Cl^-	Total Hardness mg/l $CaCO_3$	Total Alkalinity mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth	166	308	161	7.9	66
B	Channel - Buoy No 24	15	111	90	7.9	64
C	Old Bay City Intake	27	120	95	7.9	64
D	New Bay City Intake	19	116	92	7.9	64
E	Channel - Buoy No 16	15	111	89	7.8	64
F	Off Quanicassee	39	137	93	7.9	65
G	Off Fish Point	31	127	93	8.0	65
H	Channel - Buoy No 8	12	109	88	7.9	65
I	Off Pinconning Bar	15	113	90	8.1	65
J	Off Saganing Bar	27	127	96	8.3	66
K	Channel - 16 Miles From River Mouth	15	109	90	8.0	66
L	Off South Mineshas Island	19	114	91	8.0	65
M	Off North Island	31	130	93	7.7	65
N	Off Point AuGres	31	123	86	8.2	65
O	3.25 Miles East of AuGres	19	118	90	8.0	65
P	Off Caseville	15	109	87	8.0	65
Q	Off Oak Point	12	102	84	8.0	65
R	Bell Off Whitestone	12	100	83	7.9	64
S	Near Whitestone Intake	12	102	84	7.9	64
T	Off Tawas	15	107	86	7.9	64

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of June 12, 1973

Sample	Location	Chloride mg/l Cl^-	Total Hardness mg/l $CaCO_3$	Total Alkalinity mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth	50	238	174	8.2	73
B	Channel - Buoy No 28	25	140	110	8.2	69
C	Old Bay City Intake	28	144	115	8.2	70
D	New Bay City Intake	25	140	109	8.3	68
E	Channel Buoy No 16	21	128	102	8.2	67
F	Off Quanicassee	28	146	112	8.2	72
G	Off Fish Point	28	140	105	8.1	74
H	Channel Buoy No 8	18	122	101	8.3	68
I	Off Pinconning Bar	21	136	106	8.2	69
J	Off Saganing Bar	21	130	104	8.2	70
K	Channel - 16 Miles From River Mouth	21	130	105	8.2	70
L	Off South Mineshas Island	53	208	150	8.2	75
M	Off North Island	39	158	112	8.2	76
N	Off Point AuGres	18	126	104	8.3	70
O	3.25 Miles East of Point AuGres	14	102	86	8.2	67
P	Off Caseville	36	160	112	8.2	75
Q	Off Oak Point	28	144	107	8.2	76
R	Bell Off Whitestone	14	102	89	8.2	66
S	Near Whitestone Intake	11	102	85	8.2	66

DOW CHEMICAL CO WATER QUALITY DATA
Saginaw Bay Survey of August 15, 1973

Sample	Location	Chloride mg/l Cl^-	Total Hardness mg/l $CaCO_3$	Total Alkalinity mg/l $CaCO_3$	pH	Temp °F
A	Saginaw River Mouth	160	160	122	8.1	75
B	Channel - Buoy No 24	110	116	98	7.9	74
C	Old Bay City Water Intake	110	114	99	8.2	74
D	New Bay City Water Intake	100	112	98	8.2	74
E	Channel - Buoy No 16	95	104	91	8.1	72
F	Off Quanicassee	160	134	97	8.1	74
G	Off Fish Point	140	122	93	7.9	76
H	Channel - Buoy No 8	100	106	93	8.1	75
I	Off Pinconning Bar	100	110	94	8.1	74
J	Off Saginaw Bar	95	106	92	8.3	74
K	Channel - 16 Miles From River Mouth	95	104	90	8.3	74
L	Off South Mineshas Island	110	118	94	8.2	75
M	Off North Island	110	110	86	8.3	75
N	Off Point AuGres	95	104	89	8.5	75
O	East of Point AuGres - 3.25 Miles	95	104	87	8.4	74
P	Off Caseville	105	110	88	8.4	74
Q	Off Oak Point	100	108	87	8.4	74
R	Bell Off Whitestone	95	102	87	8.4	72
S	Near Whitestone Intake	95	102	87	8.4	72
T	Off Tawas City	90	94	81	8.4	68

SAGINAW RIVER WATER QUALITY (1971-1972)
(Data in ppm)

Parameter	Weadock Intake WRC(1) Ave / Max	Intake CPCO(2) Ave / Max	Karn Intake CPCO(2) Ave / Max
Dissolved Oxygen	8.6 14.2		
Total Dissolved Solids	474 806	573 853	410 558
Suspended Solids	21.4 40.0	24.4 33.2	19.0 27.2
BOD 5-day	5.1 10.4		
Nitrogen (Total)	1.84 2.80		
Phosphorus	.27 .52	.48 .79	.32 .72
Turbidity (JTU)	12.7 28		
M - alkalinity ($CaCO_3$)	152 200	164 198	143 162
P - alkalinity ($CaCO_3$)		8 10	4 6
pH	7.9 8.6	7.9 8.3	7.8 8.2
Hardness (Total)	280.9 340.0	289.2 342.0	309.3 471.6
Silica	4.0 6.5	2.8 4.1	2.5 3.7
Volatile Solids	10.3 17.0		
Conductivity	781 1240	950 1050	603 800
Iron (Total)	8.6 14.2	.83 .94	.60 .78

Parameter	Weadock Intake WRC(1) Ave / Max	Intake CPCO(2) Ave / Max	Karn Intake CPCO(2) Ave / Max
Calcium		69.0 80.0	56.1 85.4
Magnesium		20.8 25.8	16.7 21.0
Sodium		65.7 110.0	41.0 71.6
Sulfate		70.2 129.0	56.1 95.0
Chloride	132.7 390.0	196.0 253.0	123.5 170.0
Nitrate	.64 1.40		
Phosphate (Ortho)	.112 .250	.45 .62	.38 .54
Potassium		4.3 6.5	3.1 5.1
Ammonia	.41 .85		

(1) Data collected during 1971 and 1972 by the Michigan Water Resources Commission

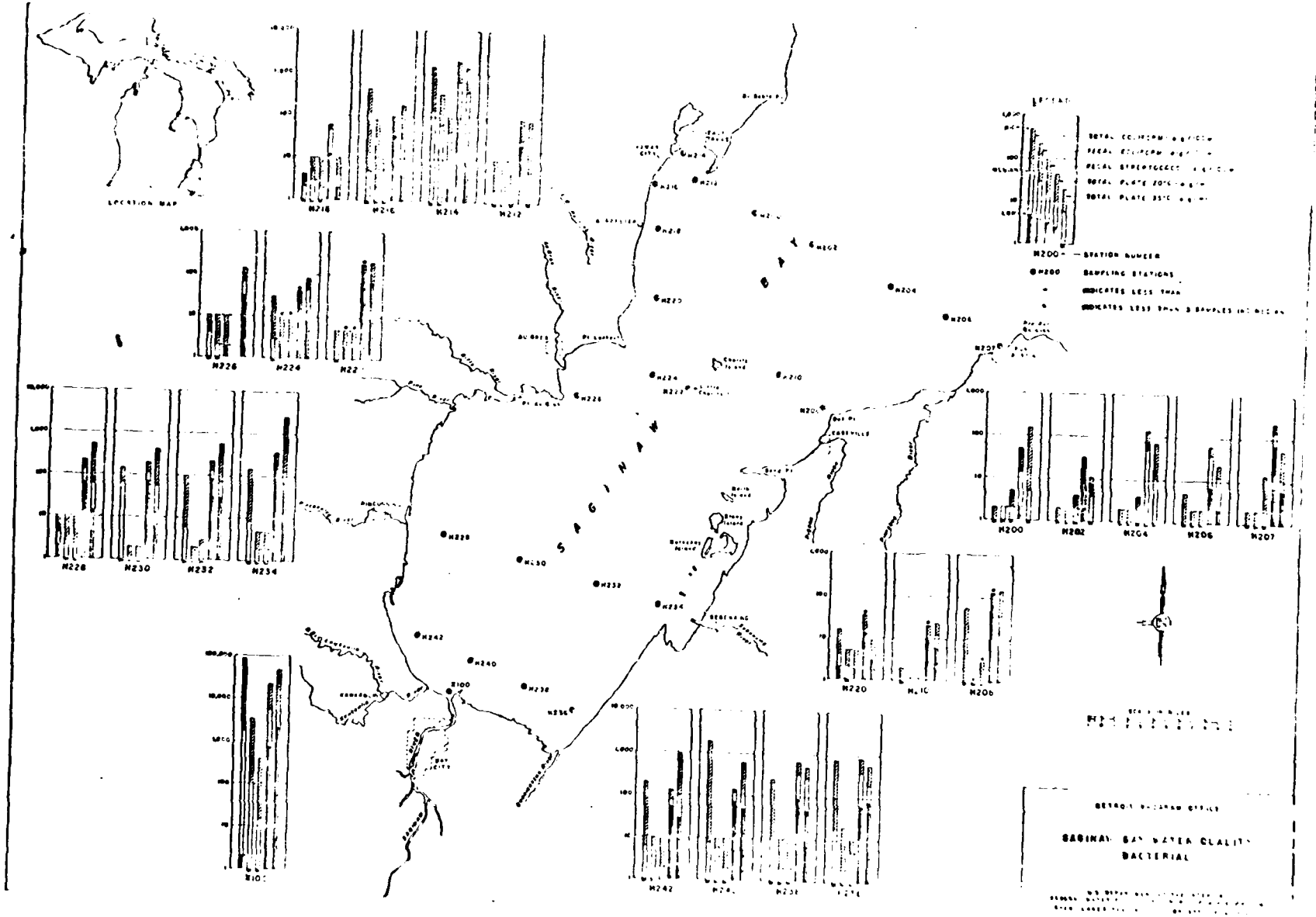
(2) Data collected during 1971 and 1972 by Consumers Power Company.

SEASONAL AVERAGES IN SAGINAW RIVER WATER QUALITY[1]

Parameter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
pH	8.0	7.9	8.0	8.0
Conductivity	814	810	697	878
Hardness	308	291	241	3 .
M. Alkalinity	185	187	132	156
Chlorides	344	367	374	443
Sulfates	95	78	66	82

[1] Derived From Consumers Power and WRC Data 1971-1972.

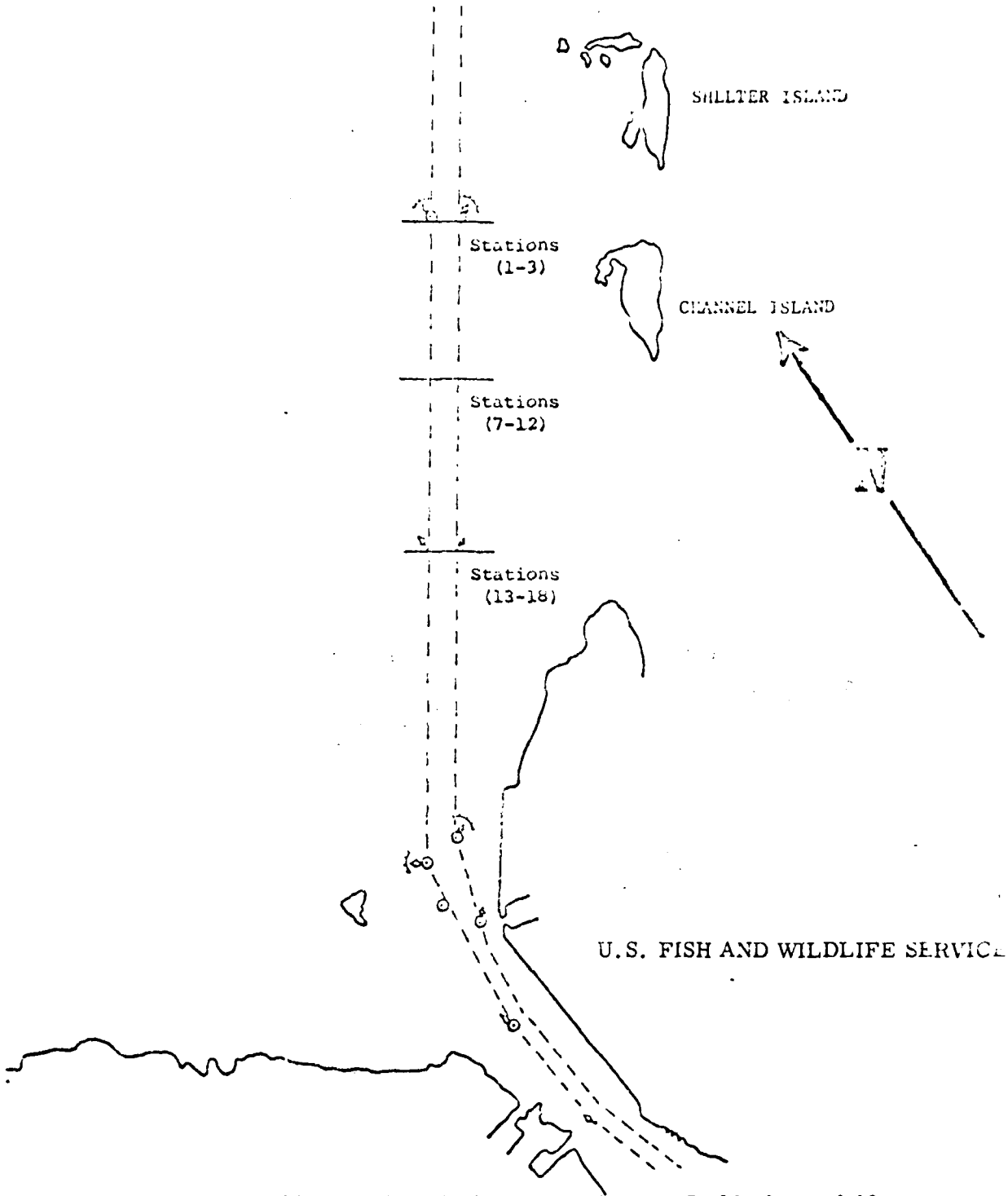
All units except pH are in ppm.


LOCATION MAP
M200 — STATION NUMBER
SAGINAW BAY WATER QUALITY
BACTERIAL

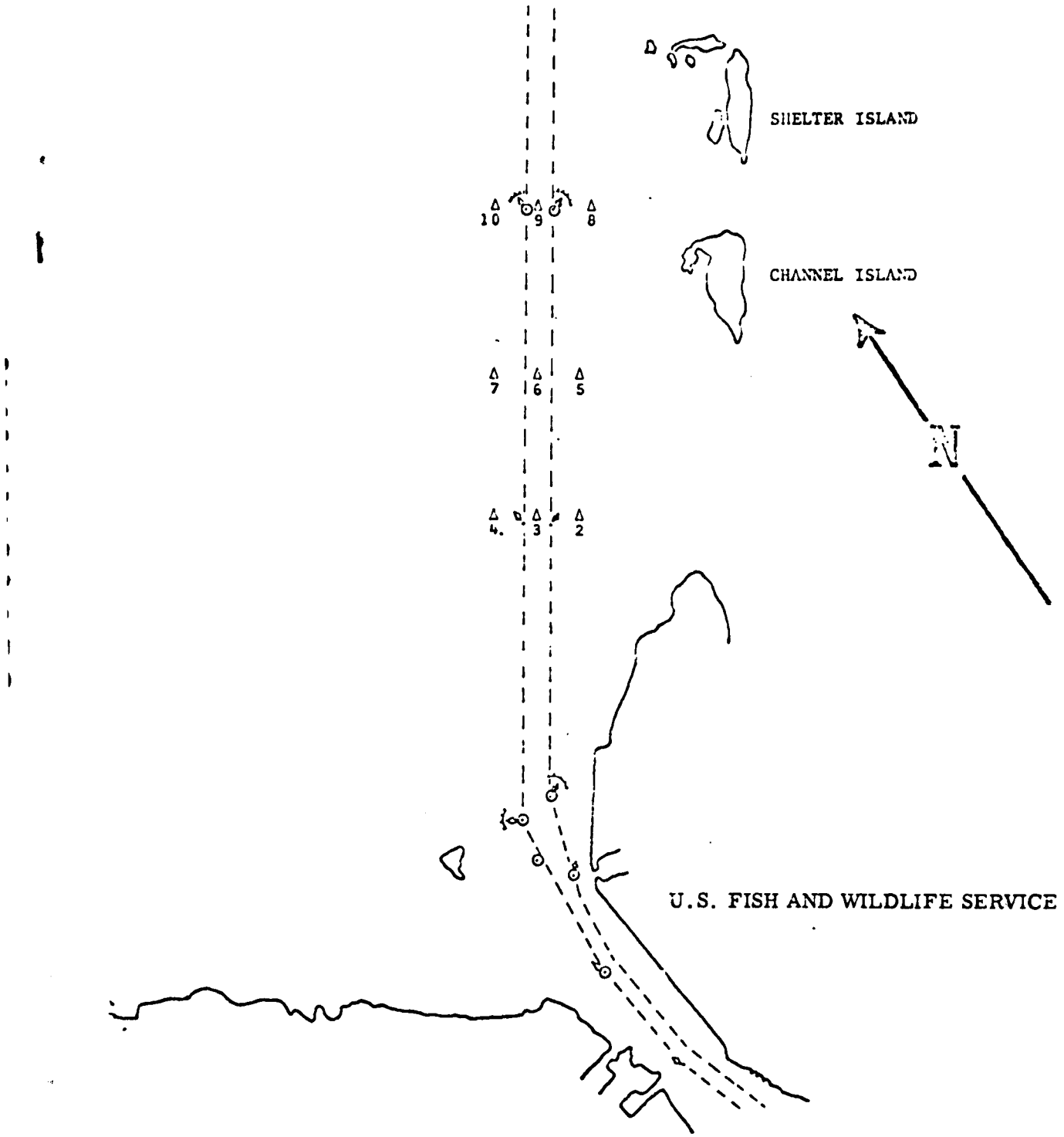
APPENDIX C

BENTHIC SAMPLING IN SAGINAW BAY

Sources: INTERIM REPORT for THE CORPS OF ENGINEERS by THE U.S. FISH AND WILDLIFE SERVICE, MICHIGAN WATER RESOURCE COMMISSION and CONSUMERS POWER COMPANY



location of sampling stations in 1973. Stations 1, 7, 12, 13, and 18 are on the bay side adjacent to the channel; stations 2, 8, 11, 14, and 17 are on the sloping sides of the channel (approximate depth, 17 feet). Stations 3, 9, 10, 15 and 16 are at the corner of the channel bottom (approximate depth of 33 feet). Transects are numbered consecutively from right to left. Samples at stations 4-6 were collected but were not enumerated.



Location of sampling stations in fall 1972. Stations 2, 4, 5, 7, 8, and 10 are on the bay floor adjacent to the channel. Stations 3, 6, and 9 are located in the center of the navigation channel. Station 1 was at the river mouth and is not included.

Table 3. Identification of benthic fauna found at the Saginaw Bay demonstration site.*

Taxon	Common name
Oligochaeta	Aquatic earthworms
Manayunkia speciosa	Polychaete worm
Chironomidae	Midges
Ceratopogonidae	Biting midges
Psychodidae	Moth flies
Chaoborus	Phantom midge
Tipulidae	Flies
Ostracoda	Seed shrimp
Cladocera	Water fleas
Copepoda	Copepods
Gammarus	Side-swimmer
Hyalella azteca	Scud
Coleoptera	Beetles
Elmidae	Riffle beetles
Dubiraphia	Riffle beetle
Hydrophilidae	Water scavenger beetles
Acarina [Hydracarina]	Water mites
Nemata	Roundworms
Bryozoa	Moss animals
Rhabdocoela	Flatworms
Hydra	Hydra
Nemertinae	Proboscis worms
Physa	Freshwater snail
Tardigrada	Water bears
Ephemeroptera	Mayflies
Caenis	Mayfly
Hydroptilidae	Caddisflies
Leptoceridae	Caddisflies

*U.S. FISH AND WILDLIFE SERVICE

Benthic fauna (number of organisms/m^2) collected during fall 1972. A plus sign [+] indicates that this taxon was present.*

Taxon	Station number and (in parentheses) rank in diversity[a/]								
	2 (4)	3 (11)	4 (2)	5 (4)	6 (11)	7 (7)	8 (5)	9 (17	10 ((
Oligochaeta	3967	5144	41	1694	9896	1136	5310	130?6	390:
Chironomidae	21	661	0	62	1921	21	21	66i	14:
Ceratopogonidae	0	0	0	0	41	0	0	21	(
Chaoborus	0	21	0	0	41	0	0	41	(
Ostracoda	0	0	0	0	0	0	0	21	(
Cladocera	103	392	21	434	1384	227	145	826	51(
Copepoda	41	289	0	62	310	248	103	3760	18(
Gammarus	0	62	0	0	0	0	0	537	(
Coleoptera	0	0	0	0	0	0	0	21	(
Acarina [Hydracarina]	0	124	0	0	248	0	0	227	2:
Nemata	0	83	0	0	62	41	0	248	4:
Bryozoa	0	+	0	0	+	+	+	+	(
Rhabdocoela	0	62	0	0	0	0	0	62	(
Hydra	0	21	0	0	0	21	0	103	(
Nemertinea	0	0	0	0	21	0	0	62	(
Physa	0	0	0	0	0	0	0	21	(
Ephemeroptera	0	0	0	0	0	0	0	21	(
Hydroptilidae	0	0	0	0	21	0	0	0	(

a/ 18 = highest; 1 = lowest

* U. S. FISH AND WILDLIFE SERVICE

Benthic fauna (number of organisms/m^2) collected on April 20, 1973.

A plus sign [+] indicates that this taxon was present. **

Taxon	Station number and (in parentheses) rank in diversity[a/]											
	1 (2)	2 (8)	3 (6)	7 (4)	8 (7)	9 (9)	13 (3)	14 (6)	15 (9)	16 (4)	17 (5)	[illegible]
Oligochaeta	331	13491	15722	62	5661	21590	3037	11694	46423	22210	3656	[illegible]
Manayunkia speciosa	0	537	0	0	0	0	0	0	0	0	0	[illegible]
Chironomidae	0	207	826	62	1735	2376	0	1529	3987	2500	62	[illegible]
Chaoborus	0	0	0	0	0	21	0	0	0	0	21	0
Erpicidae	0	0	0	0	0	0	0	0	62	0	0	0
Ostracoda	0	62	186	0	20660	1260	0	20660	1529	661	145	10
Cladocera	0	21	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	0	21	0	0	0	0	0	0	0	0
Elmidae	0	0	0	0	0	21	0	0	0	0	21	0
Acarina (Hydracarina)	0	0	124	83	0	165	21	207	393	0	0	21
Nemata	21	62	227	0	103	310	21	145	393	103	0	0
Bryozoa	0	+	+	0	+	+	0	0	+	0	0	0
Rhabdocoela	0	21	0	0	186	41	0	0	21	0	0	0
Tardigrada	0	0	0	0	103	0	0	41	0	0	0	0
Leptoceridae	0	0	0	0	0	0	0	0	41	0	0	0

[a/] 15 = highest; 1 = lowest

* Indicates a mean of 2 samples.

** U.S. FISH AND WILDLIFE SERVICE

Benthic fauna (number of organisms/m^2) collected during early May, late May, and mid October of 1973. A plus sign (+) indicates that taxon was present.**

Taxon	Station number and (in parentheses) rank in diversity[a/] Early May sample collection											
	7* (4)	8 (6)	9 (7)	10 (5)	11 (7)	12 (5)	12 (4)	14 (3)	15 (7)	16 (5)	17* (8)	18* (5)
Oligochaeta	392	22726	31932	28511	4091	413	3512	4483	32436	14917	1539	206
Chironomidae	10	1012	971	2459	930	62	21	0	3078	1591	51	0
Ceratopogonidae	0	0	0	0	21	0	0	0	0	0	10	0
Ostracoda	0	26660	1715	1818	21	0	0	20660	1777	558	10	0
Gammarus	0	0	0	0	0	21	0	0	0	0	0	0
Elmidae	0	0	0	0	0	21	0	0	0	0	10	0
Dubiraphia	0	0	0	0	0	0	0	0	21	0	0	0
Acarina [Hydracarina]	0	124	124	0	21	0	0	124	0	0	0	10
Nemata	10	0	62	744	21	21	0	0	289	0	10	20
Bryozoa	0	+	0	+	+	0	+	0	+	+	+	0
Rhabdocoela	10	0	165	0	0	0	21	0	62	0	10	0
Tardigrada	0	124	124	0	0	0	0	0	0	0	0	0

[a/] 12 - highest; 1 = lowest

* Indicates a mean of 2 samples.

** U.S. FISH AND WILDLIFE SERVICE

Taxon	Station number and (in parentheses) rank in diversity[a] Late May sample collection **											
	7* (3)	8 (6)	9 (7)	10 (5)	11* (4)	12* (2)	13* (8)	14 (8)	15 (7)	16 (5)	17* (4)	18* (5)
Oligochaeta	302	7293	19214	32560	1146	320	5278	19544	19627	10888	836	227
Chironomidae	0	661	1240	3636	0	0	185	909	868	393	41	0
Ceratopogonidae	10	0	0	0	0	0	10	0	0	0	0	0
Chaoborus	0	0	0	0	0	0	0	21	0	0	10	0
Ostracoda	0	2087	4297	1364	10	0	247	1591	1715	62	51	464
Hyalella azteca	10	0	0	0	0	0	0	0	0	0	0	0
Elmidae	0	0	0	227	0	0	0	0	0	0	0	0
Hydrophilidae	0	0	21	0	0	0	0	0	0	0	0	0
Acarina (Hydracarina)	0	0	0	0	0	0	51	21	21	0	0	0
Nemata	0	186	41	0	20	0	20	21	165	62	0	30
Bryozoa	0	+	+	+	+	0	+	+	+	+	0	+
Rhabdocoela	0	103	83	0	0	0	10	21	145	0	0	10
Cachis	0	0	0	0	0	10	0	0	0	0	0	0

[a] 13 = highest; 1 = lowest

* Indicates a mean of 2 samples.

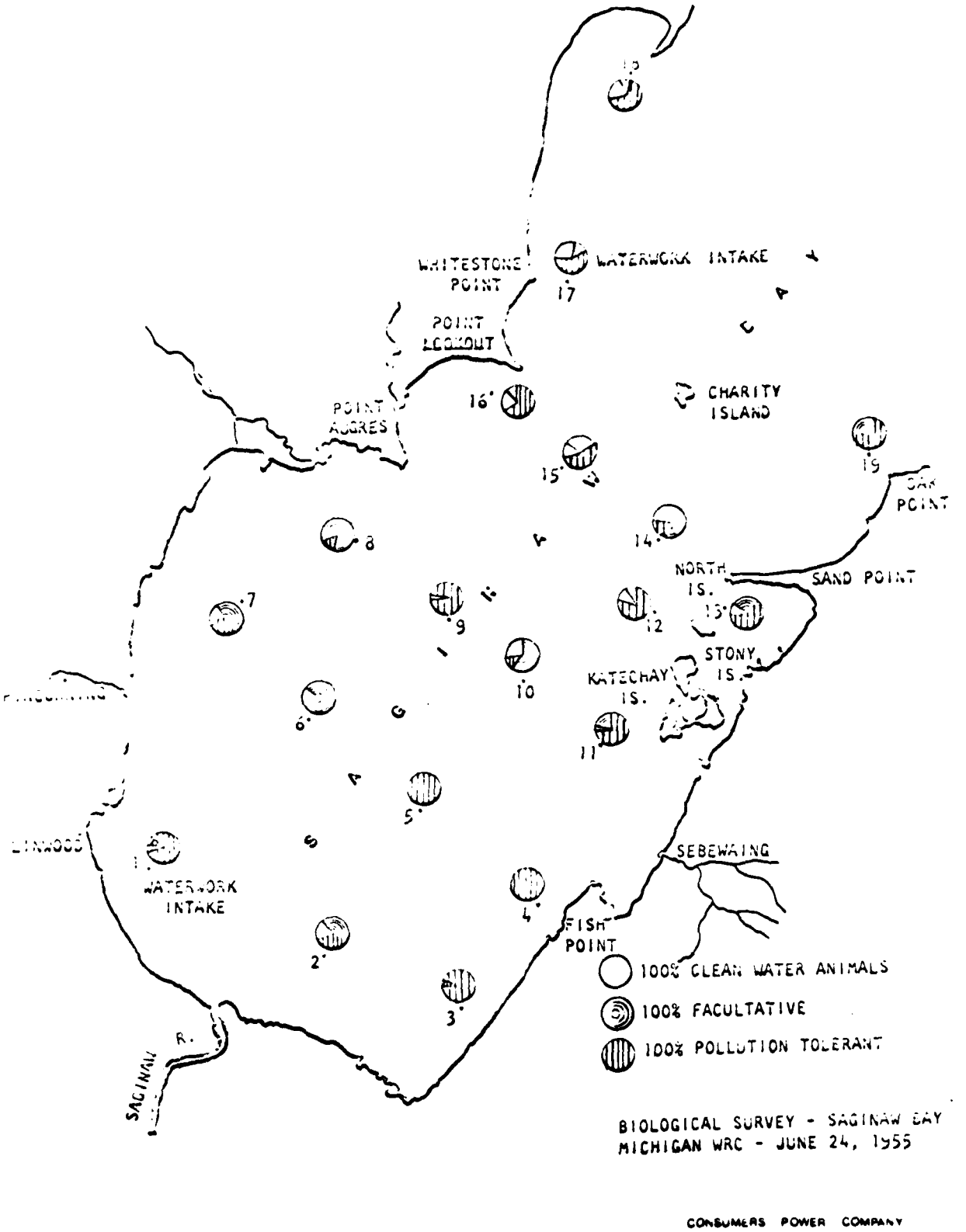
** U.S. FISH AND WILDLIFE SERVICE

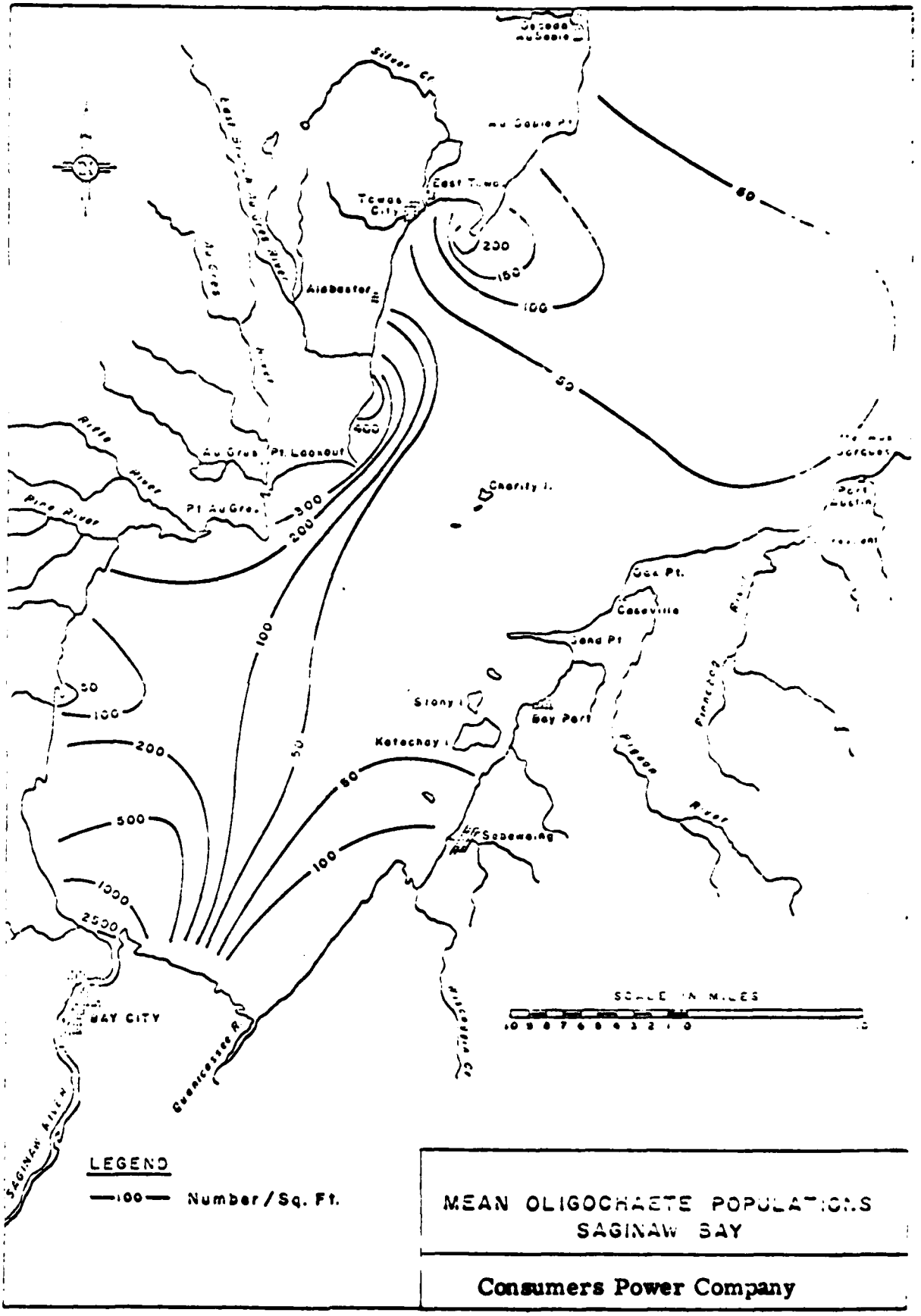
Taxon	Station number and (in parentheses) rank in diversity[a] Mid October sample collection**											
	7* (4)	8 (6)	9 (6)	10 (7)	11* (4)	12* (2)	13* (4)	14 (2)	15* (4)	16* (8)	17* (3)	18 (4)
Oligochaeta	4276	2231	1364	8760	2737	2251	2117	1508	5155	4744	868	1559
Chironomidae	30	62	248	1715	83	123	51	0	1354	1477	21	30
Ceratopogonidae	0	0	0	83	0	0	0	0	0	0	0	0
Chaoborus	0	0	0	0	0	0	0	0	0	42	0	0
Ostracoda	278	0	41	227	10	0	10	3677	445	351	0	0
Gammarus	0	21	21	0	0	0	0	0	0	0	0	0
Hyalella azteca	0	21	0	0	0	0	0	0	0	0	0	0
Elmidae	0	0	0	0	0	0	0	0	0	10	0	0
Acarina [Hydracarina]	0	0	103	0	0	0	0	0	0	42	21	0
Nemata	10	21	21	83	10	0	0	0	0	21	0	0
Bryozoa	0	0	0	+	0	0	0	0	+	+	0	0
Hydra	0	21	0	0	0	0	0	0	0	0	0	0
Nemertinea	0	0	0	0	0	0	10	0	0	0	0	0

[a] 13 = highest; 1 = lowest

* Indicates a mean of 2 samples.

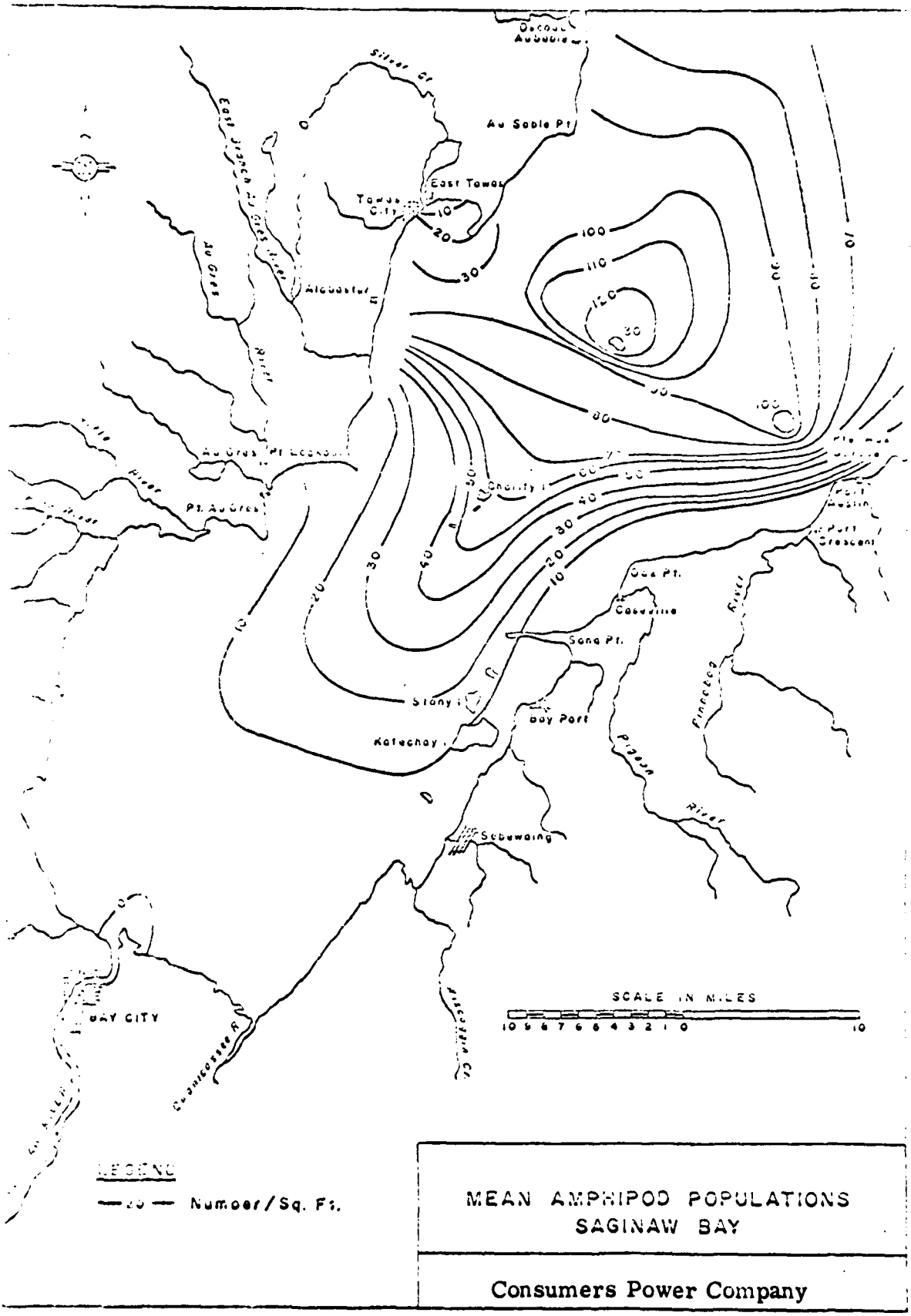
** U.S. FISH AND WILDLIFE SERVICE


WHITESTONE POINT
WATERWORK INTAKE
17
POINT LOOKOUT
POINT AGRES
16
CHARITY ISLAND
15
19
OAK POINT
14
8
NORTH IS.
SAND POINT
7
9
12
13
STONY IS.
10
KATECHAY IS.
6
11
5
SEBEWAING
WATERWORK INTAKE
1
4
2
FISH POINT
3
SAGINAW R.
100% CLEAN WATER ANIMALS
100% FACULTATIVE
100% POLLUTION TOLERANT
BIOLOGICAL SURVEY - SAGINAW BAY
MICHIGAN WRC - JUNE 24, 1955
CONSUMERS POWER COMPANY



MEAN OLIGOCHAETE POPULATIONS
SAGINAW BAY

Consumers Power Company



MEAN AMPHIPOD POPULATIONS
SAGINAW BAY

Consumers Power Company

APPENDIX D

PERTINENT CORRESPONDENCE

United States Department of the Interior

NATIONAL PARK SERVICE
MIDWEST REGION
1709 JACKSON STREET
OMAHA, NEBRASKA 68102

IN REPLY REFER TO:
L7423 MWR CL

MAR 5 1975

Colonel James E. Hays
District Engineer
Detroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Reference your notices of February 12, 1975, pertaining to maintenance dredging in the St. Clair River, Saugatuck Harbor, and Saginaw River, Michigan.

No established or studied units of the National Park Service or sites registered or eligible for registration as National Historic, Natural or Environmental Educational Landmarks appear to be adversely affected by the proposal. Accordingly, we have no objections to the performance of this work as related to these areas.

The National Park Service Midwest Archeological Center has no records of any archeological sites in the immediate area of the proposed actions. Our only comment is that in the event archeological remains are revealed by dredging activities, operations should be suspended and immediate notification provided to Dr. James E. Fitting, State Archeologist, Michigan History Division, Michigan Department of State, 208 North Capitol Avenue, Lansing, Michigan 48918.

The State Historic Preservation Officer should be contacted for information on other properties eligible for, or already entered on the National Register of Historic Places. The SHPO to contact is Dr. Martha Bigelow, Director, Michigan History Division, Department of State, Lansing, Michigan 48918.

The National Register should also be consulted. The National Register includes established National Park Service historic areas, national historic landmarks and properties of regional, state or local significance which are nominated by the State Historic Preservation Officer.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

...ld these consultations reveal that any cultural resources will suffer adverse impact because of the proposed actions, a detailed plan for preservation of threatened remains or mitigations of the impact should be implemented prior to the issuance of the permits.

Sincerely yours,

Merrill D. Beal
Regional Director

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to
COMMANDER (oep)
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199
Phone: 216-522-3919

5922
5 March 1975

Department of the Army
Ditroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Re: Notices of Application for Permit
NCECO-O 16-SG
NCECO-O 20-SG
NCECO-O 12-STC

Dear Sir:

The Notices of Application for Permit listed above have been reviewed by this office and at this time we interpose no objections.

Sincerely,

E. J. SULLIVAN
Commander, U. S. Coast Guard
Chief, Marine Safety Division (Acting)
By direction of the Commander,
Ninth Coast Guard District

Copy to:
COMDT(G-WEP)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Federal Building, 14 Elm Street
Gloucester, Massachusetts 01930

March 10, 1975

Col. James E. Hays
District Engineer
Department of the Army
Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

We have received project plans for the public notices listed on the attached sheet concerning Federal navigation channel maintenance dredging projects.

Although we appreciate having the opportunity to review these notices of application, we will be unable to evaluate their adequacy or to comment upon them because of present budget and staff limitations.

Sincerely yours,

Russell T. Norris
Regional Director

Attachment

Public Notice No	Date
NCECO-O	Feb. 3, 1975
NCECO-O-11WL	Feb. 3, 1975
NCECO-O-12STC	Feb. 12, 1975
NCECO-O-15FR	Feb. 3, 1975
NCECO-O-16SG	Feb. 12, 1975
NCECO-O-17LUD	Feb. 3, 1975
NCECO-O-18CH	Feb. 3, 1975
NCECO-O-19PE	Feb. 3, 1975
NCECO-O-20SG	Feb. 12, 1975
NCECO-O-21LE	Feb. 3, 1975
NCECO-O-23LL	Feb. 3, 1975

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN STREET
CHICAGO, ILLINOIS 60604

Colonel James E. Hays
District Engineer
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

MAR 25 1975

Dear Colonel Hays:

Reference is made to Public Notice NCECO-O 16-SG for Maintenance Dredging of the Federal Navigation Channels in Saginaw River, Michigan which was transmitted to us on February 12, 1975. We note it is the purpose of the proposed action to dispose maintenance dredgings from the outer bay channel beyond a point about 6.5 miles from the mouth of the river in open water at a site about 10.5 miles lakeward of the river mouth. According to the Public Notice, this material is "from the clean section of the harbor." While it is true that the bottom sediments in the river channel and inner bay are classified as polluted, the bottom sediments in the outer harbor out to EPA Survey Station SB7 (channel markers R.6 and G.7) to about 12 miles lakeward of the river mouth are also classified as polluted. Therefore, the material to be dredged by this project is considered polluted and should be placed in a confined disposal facility. Open lake disposal of this material would not be consistent with our program to improve the water quality of Saginaw Bay.

As you know, we reviewed the Draft Environmental Impact Statement for the Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan on February 14, 1975. A copy of our comments have been attached for your convenience.

Should you have any questions regarding our comments or would care to meet with us, please contact me at 312-353-5756.

Sincerely yours,

Donald A. Wallgren

Donald A. Wallgren
Chief,
Federal Activities Branch

Attachment
As Stated

FEB 14 [illegible]

Mr. P. McCallister
Chief, Engineering Division
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

We have completed our review of the Draft Environmental Impact Statement (EIS) for Saginaw River Dredge Disposal Project at Saginaw Bay, Michigan which was transmitted to us on December 19, 1974. We have classified our comments as Category LO-2. Specifically, we have no major objections to the proposal as described in the EIS. However, we believe additional information should be provided in the Final EIS regarding the design of the confined disposal facility (CDF). The classification and date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on other agencies projects. The following comments are for your consideration in the preparation of the Final EIS.

The Draft EIS lacked some general information on the design of the CDF which would aid our review and assessment of the impacts. The design configuration of the CDF, the location of the outfall and pumpout facilities, and the effects the bay currents will have upon the clay core material before the armor stone is in place should be discussed in the EIS. If there are alternative design configurations, each design should be described. Maps and diagrams should suffice for this additional information.

No mention was made to the type of dredge to be employed for maintenance operations. In general, the use of hopper dredges should be minimized in polluted harbors because they allow fine materials to be discharged during the concentrating of solids in the hoppers. Selection of dredges is dependent on availability and economics; however, the effects on the environment should also be one of the considerations.

Discharges from the CDF should be monitored outside the 100-foot mixing zone for turbidity and total and suspended solids. If the monitoring indicates levels of suspended solids in excess of 15 mg/l, we recommend that further monitoring for other parameters be conducted to determine whether Federally approved State Water Quality Standards are exceeded. If these standards are violated, increased settling times will be necessary before discharge over the weir. Chemical flocculents may have to be added to facilitate settling

74-163-L

or dual settling ponds utilized if increased detention time proved to be an insufficient measure to meet standards.

A discussion in the Final EIS should be presented which would completely elucidate whether or not thermal currents contributed by Consumers Power's electric generating stations would have any interaction with the effluents discharged over the weir. If so, septic, odorous conditions could develop.

Information should be provided on the present lake levels, the height the CDF dikes will be above the present lake levels and how often wave action will overtop the CDF. Since the location of the proposed CDF is 2-1/2 miles offshore, the effects on currents and shoreline damage should be discussed.

We appreciate the opportunity to review this Draft EIS. When the Final EIS is filed with the Council on Environmental Quality, please forward two copies to us.

Sincerely yours,

Donald A. Wallgren
Chief,
Federal Activities Branch

cc: CEQ
Nathl Weaver, OFA, Wash., D. C.
F. Corrado, OPA, Region V
D. Kraus, GLSB
A. R. Winklhofer, Dir., MODO
R. Mustard, FAS

FRANZ/dh

FINAL ENVIRONMENTAL STATEMENT

MAINTENANCE DREDGING OF THE FEDERAL NAVIGATION CHANNELS IN THE SAGINAW RIVER AND SAGINAW BAY, MICHIGAN

APPENDIX E

RESPONSE TO DRAFT
ENVIRONMENTAL IMPACT STATEMENT

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

September 23, 1975

U.S. Army Engineer District, Detroit
P.O. Box 1027
Detroit, Michigan 48231

Attn: Environmental Resources Branch

Dear Sir:

This is in response to your request of August 22, 1975 for comments on the environmental statement for the proposed maintenance dredging of the Saginaw River and Saginaw Bay Federal Navigation Channels, Michigan. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969; the National Historic Preservation Act of 1966; Executive Order 11593 of May 13, 1971; and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800) the Advisory Council on Historic Preservation has determined that your draft environmental statement is inadequate regarding our area of expertise as it does not contain sufficient information to enable the Council to comment substantively. Please furnish additional data indicating:

a. Compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470(f). The Council must have evidence that the most recent listing of the National Register of Historic Places has been consulted (see Federal Register, February 4, 1975, and monthly supplements each first Tuesday thereafter) and that either of the following conditions is satisfied:

   1. If no National Register property is affected by the project, a section detailing this determination must appear in the environmental statement.

   2. If a National Register property is affected by the project, the environmental statement must contain an account of steps taken in compliance with Section 106 and a comprehensive discussion of the contemplated effects on the National Register property. (Procedures for compliance with Section 106 are detailed in the Federal Register of January 25, 1974, pp. 3366-3370).

b. Compliance with Executive Order 11593 of May 13, 1971.

1. In the case of land under the control or jurisdiction of the Federal Government, a statement should be made as to whether or not the proposed undertaking will result in the transfer, sale, demolition, or substantial alteration of potential National Register properties. If such is the case, the nature of the effect should be clearly indicated.

2. In the case of lands not under the control or jurisdiction of the Federal Government, a statement should be made as to whether or not the proposed undertaking will contribute to the preservation and enhancement of non-federally owned districts, sites, buildings, structures, and objects of historical, archeological, architectural, or cultural significance.

To insure a comprehensive review of historical, cultural, archeological, and architectural resources, the Advisory Council suggests that the final environmental statement contain evidence of contact with the Michigan State Historic Preservation Officer and that a copy of his comments concerning the effects of the undertaking upon these resources be included in the final statement.

Should you have any questions or require any additional assistance, please contact Jordan Tannenbaum of the Advisory Council staff at 202-254-3380.

Sincerely yours,

John D. McDermott
Director, Office of Review and Compliance

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA 19082
(215) 596-1618

8400
October 6, 1975

Mr. P. McCallister
Chief, Engineering Division
Department of the Army
Detroit District, Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Refer to: NCEED-ER, Draft Environmental Statement, Saginaw River and Saginaw Bay, MI

Dear Mr. McCallister:

Since the above project has no direct effect on woodland and minor indirect effects, we have no comments.

Thank you for the opportunity to review this report.

Sincerely,

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE Room 101, 1405 South Harrison Road
East Lansing, Michigan 48823

September 18, 1975

U.S. Army Engineer District, Detroit
P.O. Box 1027
Detroit, Michigan 48231
ATTN: Environmental Resources Branch

Gentlemen:

The draft environmental impact statement for the proposed maintenance dredging of the Saginaw River and Saginaw Bay Federal navigation channels to the authorized project depth was received by this office for review and comment.

We have reviewed the draft environmental impact statement and do not have any comments.

We appreciate the opportunity to review and comment on this proposed project.

Sincerely yours,

For Arthur H. Cratty
State Conservationist

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST
CHICAGO, ILLINOIS 60604

OCT 20 1975

Mr. P. McCallister, Chief
Engineering Division
Detroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

We have completed review of the Draft Environmental Impact Statement (EIS) for the Maintenance Dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan, which was sent to us on August 22, 1975. Based on information provided in the Draft EIS, we have no major objections to the proposed dredging, but request additional information to more fully assess the total project impact. The following comments are for your use in preparing the Final EIS.

The EIS indicated that the bottom sediment material from approximately 12 miles from the river mouth lakeward was unpolluted. Since our agency has not sampled this area, the status of this material is not known at the present time. We will be taking bottom sediment samples at Sebewaing at the end of October. We will sample beyond the 12 mile point when we are in the area later this month. Since it is proposed to open lake dispose this material during normal maintenance operations, additional information on this portion of the project should be provided. The EIS should detail the quantity of unpolluted material to be dredged, the location of the disposal site, the quality of the aquatic and benthic habitat at the disposal site and whether or not there are potable water intakes near the disposal site.

Material dredged from the 17.5 mile point of the Saginaw River upstream to the project limits will be disposed of on Middle Ground Island. Bay City provides this site, and periodically removes the material to the City's sanitary landfill. These polluted materials, when disposed of at the sanitary landfill, should be covered by an impervious material to prevent pollutants from re-entering any watercourse.

Based on the above discussion, we have classified the project as LO (Lack of Objection) and Categorized the EIS as 2 (additional information necessary). We appreciate the opportunity to review this Draft EIS. When the Final is filed with the Council on Environmental Quality, please forward three copies to us. If you have any questions regarding our comments contact Mr. Gary A. Williams at 312-353-5756.

Sincerely yours,

Donald A. Wallgren, Chief
Federal Activities Branch

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
230 S. DEARBORN STREET, 32nd FLOOR
CHICAGO, ILLINOIS 60604

(ER-75/831)

September 30, 1975

Colonel James E. Hays
District Engineer
U. S. Army Engineer District
Detroit
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

The Department of the Interior has reviewed the Draft Environmental Statement for Maintenance Dredging of Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan, as requested in your transmittal letter to our Assistant Secretary, Program Development and Budget. Our comments relate to areas of our jurisdication and expertise and have been prepared in accordance with the National Environmental Policy Act of 1969.

The statement adequately describes probable impacts on fish and wildlife resources that will occur as a result of project activities in the Saginaw River and Saginaw Bay.

No evaluation of cultural resources has been presented in this statement. The EIS should include a statement that no properties listed on or eligible for nomination to the National Register of Historic Places would be affected by the project. The Corps of Engineers should make this determination by checking the National Register and its monthly supplements and by consulting with the State Historic Preservation Officer. If listed properties would be affected, the procedures of the Advisory Council on Historic Preservation (36 CFR 800) must be followed. In the case of a questionable property, a determination of eligibility can be obtained from the Secretary of the Interior.

Conclusions on the presence or absence of archeological resources within the project area based on professional consultation and investigation should be presented in the statement. We recommend that the Corps of Engineers contact the State Archeologist, Dr. James E. Fitting, for assistance in this regard.

We suggest that Section 3, paragraph 3.03, include identification of the agency which will manage the newly formed project lands.

Sincerely yours,

for Madonna F. McGrath
Acting Special Assistant
to the Secretary

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD ILLINOIS 60430

September 11, 1975

IN REPLY REFER TO: 05-00.5

U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Attention: Environmental Resources Branch

Gentlemen:

The following draft environmental statements have been reviewed.

(1) Maintenance Dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan.

(2) Maintenance Dredging of the Federal Navigation Channels in Grand River Harbor and Grand River, Michigan.

Neither EIS comments on the effects of dredging near highway or other structures within the project area. Our concern is that the dredging operations could create scour patterns or possibly undermine the footings of piers or abutments of such structures. If no adverse effects are anticipated, an affirmative statement and the basis for it should be included in the statement.

It has been noted that the last four draft statements from your office have been sent directly to our Division office in Lansing, Michigan for review and comment. We would again like to bring to your attention that the appropriate point of contact to obtain FHWA review and comment on draft environmental statements is the Regional office. We would appreciate future requests for review of draft statements be forwarded to this office.

The opportunity to review and comment on the draft environmental statement is appreciated.

Sincerely yours,

Donald E. Trull
Regional Administrator

BY: W. G. Emrich
W. G. Emrich, Director
Office of Environment and Design

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

HOWARD A. TANNER, Director

October 3, 1975

Mr. Philip McCallister, Chief
Engineering Division
Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

We have reviewed the draft environmental impact statement for the proposed maintenance dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan.

We find the statement to be generally adequate in describing the environmental impacts associated with the project. However, additional information and clarification is needed in some areas. It is stated (page 2) that the disposal of polluted river bottom sediments will continue to be placed in a diked area on Middle Ground Island adjacent to the Bay City Solid Waste Disposal Facility. This is an annual volume of approximately 150,000 cu. yd. The dredged material has been allowed for use (in dry form) for daily or supplemental cover purposes at the solid waste facility, but not for use as a final cover. The report states that "the length of service of Middle Ground Island as a disposal site depends on both the quantity of materials deposited at the site and the amounts removed." Please be advised that the remaining life expectancy of the Bay City Landfill is about two years. Because no consideration is likely to be given to expansion of the landfill at this location, it would appear that this situation would have an effect on the proposed project. This should be addressed in the environmental statement.

Additionally, no description is provided in regard to the type and quality of retention areas at the disposal sites. A full description along with construction specifications should be provided. This would include the type of containment and type of weir, along with retention times and dewatering

modes. It must be assured that pollution is not returned to the aquatic systems via the leachate.

The information provided on the amount of waterborne commerse via the Saginaw River Channel is not complete. It is stated that 4 million tons of cargo passed through the river channel during 1973 (page 19). However, no information is given, either in the text or in table 8 (pages 36, 37), as to the point of destination of these commodities along the Saginaw River. A "point of destination" category should be added to table 8 (page 37) to identify the point of unloading of these commodities.

Alternative modes (i.e. rail, trucking) of transporting commodities to points upriver should be treated in the "Alternatives" section on page 21. The cost of rail or truck shipment (from a point near the mouth of the River) should be balanced against the cost of dredging some 19 miles of river from Saginaw to lower Bay City. The cost of constructing, operating, and maintaining a confined disposal site of larger capacity should also be determined and presented in this section.

It is mentioned (under alternatives) that the costs of waterborne transport would rise if the channel were not dredged. It should also be mentioned this might be balanced by the reduction of maintenance and disposal costs if the maintenance were discontinued or reduced in scale.

The alternatives for the project (page 21) do not include alternate sites for disposal. We are especially concerned that on-land disposal is not treated in the statement as an environmentally desirable alternative. In the long run this method would be the cheapest and easiest to build and maintain. Have on land disposal sites been sought and considered? If on-land sites have been considered and rejected, or have not been available, this should be covered in the statement.

Because of shallow depth of the inner bay and its importance to productivity for fish and wildlife, we feel open water disposal is detrimental to the aquatic biota. Therefore, further investigation is needed to determine a more satisfactory method of disposal. This need should be addressed in the environmental statement. Also, more specific information is needed (in addition to fish surveys) as to how fish will be affected by the project. For example, what are the times of dredging and which species may be affected and to what degree? This information should be included.

Shelter and channel islands are used by a nesting colony of several thousand gulls.

It appears that deposition of polluted dredgings on channel and shelter islands would disrupt the nesting activity of as many as 10,000 gulls. The creation of a larger island would only be beneficial to gulls if it were left undisturbed and not subjected to the proposed human uses such as boating, camping, picnicking, etc. The environmental statement should comment on the timing of proposed construction and disposal (gull nesting) and the limiting factors of the proposed recreational uses (access, maintenance, etc.) in more detail in the final statement.

The remainder of our comments will be addressed to page and paragraph of the text for easy reference.

Page 8 - 2.17

It is stated that an average of 7000 waterfowl hunters use the bay area annually. If this information was supplied by us we apoligize for the error. Our state surveys indicate that an average of 14,345 waterfowl hunters annually used Saginaw Bay habitats during 1965-74. The average annual hunter days involved was 106,234. Duck Stamp sales for counties adjoining the Bay would be low estimates of use because they don't take into account hunter use of the area from more distant, populous, urban counties. This information should be corrected in the final EIS.

Page 9 - 2.17

The following data should be substituted for acreage of state game and wildlife areas given.

Tobico Marsh State Game Area	1,848 acres
Nayanquing Point Wildlife Area	1,146 acres
Quanicassee Bay Wildlife Area	218 acres
Wigwam Bay Wildlife Area	146 acres
Waterfowl Bay Wildlife Area	1,790 acres
Fish Point Wildlife Area	3,076 acres

Page 14 - 3.02

What affect will the project have on the actively eroding condition of shelter and channel islands?

Page 17 - 4.08

More detail is needed concerning the problem of botulism mentioned in this section. How does the Corps propose to implement the "remedial actions" which may include flooding or drying? Where is the plan to implement such action? This should be included in the statement.

Page 19 - 4.14
No mention is made as to the relationship of the project to flood relief along the Saginaw River. Is this a factor?

Page 23 - 8.01 and 8.02
We find no basis in fact for two statements made in these sections. It is stated: (1) that the bottom will return to original status once dredging is terminated, and (2) the fact that maintenance dredging is recurrent is proof that original conditions will return if dredging was discontinued. These statements need to be explained in more detail.

Page 22 - 7.04
This information also represents an unavoidable adverse effect of the project and should be included in that section on page 20.

We trust these comments will be useful in the preparation of the final environmental impact statement. Should you have any questions please contact us.

Sincerely,

Howard A. Tanner
Director

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

STATE HIGHWAYS BUILDING — POST OFFICE DRAWER K — LANSING, MICHIGAN 48904

JOHN P. WOODFORD, DIRECTOR

October 9, 1975

Mr. P. McCallister, Chief
Engineering Division
Army Engineer District, Detroit
Environmental Resources Branch
P. O. Box 1007
Detroit, Michigan 48231

Dear Mr. McCallister:

The Environmental Liaison Section has reviewed the Draft Environmental Statement for "Maintenance Dredging of the Federal Navigation Channels in the Saginaw River and Saginaw Bay, Michigan." Although the Statement points up the obvious need for the project, we feel that discussions of the environmental setting, probable impacts and alternatives considered are inadequate.

Some examples of topics that should have been included in these discussions are as follows:

1. It is given that approximately 840,000 cubic yards of material, most of which is polluted, will be dredged. Locations for disposal of only 140,000 cubic yards of polluted material and the small amount of unpolluted material are given. It is difficult to assess the total impact of this project without information concerning location(s) of confined disposal for the remaining polluted material.

2. The Ecology Section mentioned State Game Areas considerably outside of the project area, but failed to recognize the existence of Crow Island State Game Area which is within the project area. The Crow Island State Game Area consists of 1,157 acres and is managed primarily as a waterfowl refuge with hunting prohibited, except as specified in the outstanding life lease on portions of the property. Consequently, given the importance of this area to waterfowl and marsh birds, coupled with its relation to

the Shiawassee National Wildlife Refuge and Shiawassee State Game Area, it is suggested that the importance of the Crow Island State Game Area and the probable impacts of the proposed action on it be discussed.

3. The description of the fisheries resource of the Saginaw River Drainage Basin should include mention of recent releases of steelhead trout and coho and chinook salmon in the Cass River. These introductions have been very successful, despite the necessity that the fish pass through the heavily industrialized Saginaw River corridor during migration between Lake Huron and upstream spawning areas. Since the project proposal could adversely affect these migrations, the possibility of such adverse effects occurring should be evaluated.

4. The discussion of the relationship of the proposed project to proposed area land use plans should be more specific. Two items in particular need further discussion. First, the Statement indicates that polluted material from Middle Ground Island will be removed to the city's sanitary landfill. Although such a procedure may be desirable, it is contingent upon the content of residual pollution in the fill, and the capacity of the landfill to confine such pollutants. Therefore, both the condition of the fill and the limitations of the landfill should be discussed.

   Second, it is acknowledged that 355 acres of bottom lands will be filled and that this is acceptable because the land may be useful for future recreational purposes. These future recreational uses are only vaguely described. Attempting to assuage the impacts of filling these bottom lands and open water areas with vague references to future recreational use does not address the impacts of filling these areas.

5. The Statement cites that "During construction of the disposal site, fish using the Shelter-Channel Islands for spawning and rearing activities will be required to use other areas." Anthropomorphic statements such as this greatly reduce the credibility of the Statement. The Statement should

simply indicate that project implementation will, at least temporarily, destroy fish spawning areas, and that the size of future fish populations may be reduced.

6. The Environmental Protection Agency indicates in their letter on page D-9 that the use of hopper dredges should be avoided in polluted harbors because they allow fine materials to be discharged during the concentrating of solids in the hoppers. The Alternative Section fails to mention that the use of mechanical dredges would have an advantage over hopper dredges in this regard.

In general, all sections in the Statement are too brief to adequately describe the impact of the project. Therefore, we suggest that in preparation of the Final Statement all sections be examined for such deficiencies.

Sincerely,

G. Robert Adams, Administrator
Environmental and Community
Factors Division

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48918

MICHIGAN HISTORY DIVISION
ADMINISTRATION, ARCHIVES, HISTORIC SITES, AND PUBLICATIONS
3423 N Logan Street
517-373-0510
STATE MUSEUM
505 N Washington Avenue
517-373-0515

September 29, 1975

U.S. Army Corps of Engineers, Detroit District
P.O. Box 1027
Detroit, MI 48231
Attn.: Environmental Resources Branch

Gentlemen:

Dr. Lawrence Finfer, Environmental Review Coordinator, has reviewed the proposals for maintenance dredging and disposal in the following areas:

Lake St. Clair
St. Clair River
Saginaw Bay/River
St. Marys River/Straits of Mackinac
Grand Haven Harbor/Grand River

He concludes that these projects will have no effect on cultural resources. Thank you for giving us the opportunity to comment.

Sincerely yours,

Martha M. Bigelow

Martha M. Bigelow
Director, Michigan History Division
and
State Historic Preservation Officer

SAGINAW-MIDLAND WATER SUPPLY SYSTEM

4678 S. Three Mile Road — Bay City, Michigan 48706

Junction Pumping Station - Office
4678 S. Three Mile Rd.
Bay City, Mich.
Tel. (517) 684-2220

Pinconning Pumping Station
2758 N. Huron Road
Pinconning, Mich.
Tel. (517) 879-4241

Whitestone Pumping Station
720 N. Huron Road
AuGres, Mich.
Tel. (517) 876-2571

September 17, 1975

Re: NCEED-ER

Department of the Army
Detroit District Corps of Engineers
P. O. Box 1027
Detroit, Michigan

Attention: P. McCallister, Chief, Engineering Div.

Dear Mr. McCallister:

Comment on the Draft Environmental Statement related to the dredging project in the Saginaw River and Saginaw Bay Federal navigation channels is offered below.

ALL DREDGING DISPOSAL SHOULD BE DELIVERED INTO THE PROPOSED DIKED DISPOSAL AREA.

The Draft Environmental Statement says that only a small portion of the average annual shoaling volume is non-polluted. Disposal of this small volume in the open water disposal area shown in Figure 2 is our objection. No sharp line isolates polluted areas. Validity of the non-polluted material presumption is uncertain. No open water disposal should be allowed, since the small amount of material presumed non-polluting will have little effect on the overall project cost if placed in the diked disposal area.

Your consideration for our objection is requested.

Sincerely,

SAGINAW-MIDLAND WATER SUPPLY SYSTEM

Willard O. Ashmore
Secretary-Treasurer - Manager

WOA:dh

WATER AT YOUR SERVICE

APPENDIX F

COMMON AND SCIENTIFIC NAMES OF FISH AND WILDLIFE IN THE AREA OF THE FEDERAL NAVIGATION CHANNELS

FISH

Common Name	Scientific Name
Catfish, channel	Ictalurus punctatus
Bullhead	Ictalurus spp.
Smelt	Osmerus mordax
Sucker, white	Catostomus commersoni
Carp	Cyprinus carpio
Yellow perch	Perca flavescens
Walleye	Stizostedion vitreum
Whitefish	Coregonus clupeaformis
Chubs	Hybopsis spp.
Lake herring	Clupeidae
Rock bass	Ambloplites rupestris
Crappies	Pomoxis spp.
Bluegill	Lepomis macrochirus
Gizzard shad	Dorosoma cepedianum
Largemouth bass	Micropterus salmoides
Smallmouth bass	Micropterus dolomieui
Alewife	Alosa pseudoharengus
Northern pike	Esox lucius
Chinook salmon	Onchorhynchus tschawytscha
Coho salmon	O. kitsutch
Brown trout	Salmo trutta
Brook trout	Salvelinus fontinalis
Lake trout	Salvelinus namaycush
Rainbow trout	Salmo gairdneri
Spottail shiner	Notropis hudsonius

MAMMALS

Common Name	Scientific Name
Raccoon	*Procyon lotor*
Weasel	*Mustela* spp.
Mink	*Mustela vison*
Skunk	*Mephitis mephitis*
Opossum	*Didelphis marsupialis*
Red Fox	*Vulpes fulva*
Muskrat	*Ondatra zibethica*
Cottontail rabbit	*Sylvilagus flordanus*
Fox squirrel	*Sciurus niger*
Gray squirrel	*Sciurus carolinensis*
Whitetail deer	*Odocoileus virginianus*

BIRDS

Common Name	Scientific Name
Coot	*Fulica americana*
Rails	*Rallus* spp.
Geese	Anserinae
Swans	Cygninae
Diving ducks	Aythyinae
Dabbling ducks	Anatinae
Gulls	Larinae

GLOSSARY

APPENDIX G

Absorption	- Ability to attract and hold, as water in a sponge.
Accretion	- Natural or artificial build-up of land by air or water deposition.
Adsorption	- Ability to attract and hold, as paint on a board.
Aerobic	- Any biologic process which requires oxygen to function.
Alkalinity	- A measure of the capacity of a solution to neutralize hydrogen ions and is associated with pH.
Anadromous	- Type of fish that ascend rivers from the sea to spawn.
Anaerobic	- Any biologic process which does not require oxygen to function.
Anoxic	- Without oxygen. Biological decay of organic and nutrient material in bottom sediments may consume dissolved oxygen in the water and create an anoxic condition at the water-sediment interface.
Aquatic Plants	- Plants that grow in water, either floating on surface, growing up from the bottom of the body of water or growing under the surface of the water.
Artificial Nourishment	- The process of replenishing a beach by artificial means.
Barge	- A flat bottomed motorless boat used for transporting heavy loads (must be moved by tug or tender).
Baymouth Bar	- A bar extending partially or entirely across the mouth of a bay.
Benthic	- Under water at the bottom of stream, lake or harbor.
Benthic Region	- Bottom of a body of water.
Benthos	- Bottom dwelling organisms.
Biomagnification	- Increasing accumulation of a substance (such as mercury) from organism to organism in a food chain.

Biomass	- Total amount of living material in an area.
Biota	- All the species of plants and animals occurring within a certain area.
BOD	- Biochemical Oxygen Demand. A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water.
Breakwater	- A long narrow (rubble mound) pile of rock or a concrete structure in the water designed to break or moderate the effect of storm driven waves. Usually placed out into the water from shore at an entry channel to provide safer boat or ship navigation during stormy weather.
BSFW	- Bureau of Sport Fisheries and Wildlife (Federal).
Bulkhead	- A structure separating land and water areas, primarily designed to resist earth changes.
Bulkhead Line	- A "line" in the harbor beyond which a dock, pier, wharf or filled area may not extend.
CDF	- Confined Disposal Facility. Confined diked disposal area for dredged sediments.
Chelate	- Binding of heavy metal ions to organic (lignin) fibers; the ions may then be transported by the fibers as they float in the water.
Climate	- The average weather over time for a particular place.
COD	- Chemical Oxygen Demand. The amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water.
Coliform	- Any of a number of organisms common to the intestinal tract of man and animals, whose presence is an indicator of pollution.
Conductivity (Specific Conductance)	- A measure of a solution's capacity to convey an electric current.
Contaminant	- Something which will in some way degrade or dirty another thing or a natural system (such as oil in a river).

Conventional Pollutants	- Pheonols, phosphorous, nitrogen, iron, oil and grease, solids and heavy metals other than mercury.
Copper	- Copper (Cu) is a heavy metal which in trace quantities is essential to life, but which in greater amounts is toxic to life.
Cultural	- Produced by man or resulting from man's actions.
Datum Plane	- The horizontal place to which soundings, ground elevations, or water surface elevations are referred. Also REFERENCE PLANE. The plane is called a TIDAL DATUM when defined by a certain phase of the tide.
Depth, Project	- The depth below the official (LWD) lake water level to which navigation channel or basin dredging by the Corps has been authorized by Congress.
Depth, Control	- The actual depth of water that is available between the water surface and the lake or river bottom. It may be greater than project depth immediately after overdredging, or less than project depth if siltation has occurred; usually less than project depth.
Diesel Fuel	- Light fuel oil burned in diesel motors.
Diffusion	- Movement of one substance through another; for example, an odor in the air, a color in the water. Distance from the source results in more diffusion and less intensity.
Dike	- A mound of earth, sand, clay or other substance on land or in the water designed and built to retain something behind it.
Dissolved Solids	- The total amount of dissolved material, organic and inorganic, contained in water or wastes.
DNR	- Department of Natural Resources (State).
DO	- Dissolved Oxygen. The oxygen freely available in water. Unpolluted water will contain more DO than polluted water.
Dock	- A (permanent) structure projecting out from the shore to which a boat or ship can tie up.

Dredge - The equipment used to, and/or at the act of, removing muck, sand, gravel or stone sediments from harbor and/or navigation channel bottoms.

Dredge, Dipper - A barge mounted shovel, powered by steam or diesel, which operates by forcing its bucket into bottom sediments and scooping out material. Generally used to dredge sand, gravel and rock. Operates with about 80% solids 20% water.

Dredge, Clam-Shell - A barge mounted crane with a split-bucket or clam-shell suspended from it, powered by steam or diesel, which operates by dropping its clam-shell to the bottom by gravity where it is closed and lifted, along with the sediments it catches, from the bottom by wire cables. Generally used for dredging soft sediments, sand and gravel.

Dredge, Hydraulic - A barge or ship mounted vacuum suction device, sometimes fitted with an "eggbeater" type cutter head, powered by steam or diesel, which operates by breaking up the sediments with the rotating cutter head and may pump the material from the bottom through pipes to a discharge point at some distance from the equipment, in the water, on land or into a confinement facility. Generally used for dredging muck, soft sediments or sand. Operates with about 20% solids and 80% water.

Dredge, Peterson - A small bottom sediment sampling device which operates somewhat similar to a clam-shell dredge. Usually used to sample hard clay, sand, gravel or stoney bottoms.

Dredge, Ponar - A bottom sediment sampling device, smaller than a Peterson, which operates similar to a clam-shell dredge. Usually used to sample soft muck, sand and fine gravel sediments and associated benthos.

Dredge, Eckman - A bottom sediment sampling device, smaller than a Ponar, which operates similar to a clam-shell dredge, can be operated and retrieved by hand. Usually used to sample soft muck and sand and associated benthos.

Dredging - A method for deepening and widening streams, swamps or coastal waters by scraping and removing solids from the bottom to restore the authorized depths in the established projects.

Dunes	- Ridges, mounds or hills of loose, windblown material, usually sand. Stable dunes are those which are covered with vegetation and generally not readily susceptible to erosion by wind or water runoff. Unstable dunes are those which are bare of vegetation and subject to movement or erosion by both wind and water.
Dynamic	- Active processes - relating to movement.
Ecology	- The study of organisms and their physical environment.
E.I.A.	- Environmental Impact Assessment
E.I.S.	- Environmental Impact Statement. A document prepared by a Federal agency on the environmental impact of its proposals for legislation and other major actions significantly affecting the quality of the human environment. Environmental impact statements are used as tools for decision making and are required by the National Environmental Policy Act (NEPA).
Environment	- Total surroundings. Environment may refer specifically to man or animal, natural or cultural, physical, chemical, biological, social, economic or any combination of the above.
Environmental Impact	- A word used to express the extent or severity of an environmental effect.
EPA	- Environmental Protection Agency.
Erosion	- The wearing away of the land by the action of wind, water, gravity or a combination thereof. Shoreland erosion on the Great Lakes is most often a result of a combination of wind driving waves beating upon the shore and forming littoral currents, and high water levels.
Escarpment	- A high vertical rock cliff or bluff which rises sharply from the water.
Eutrophication	- Natural processes which result in water quality reduction via nutrient enrichment. Eutrophication over time changes open lakes to swamps and eventually to dry land.

Evolution	- Change over time.
Fauna	- Animals on land or in the water.
Fecal Coliform	- A group of organisms common to the intestinal tracts of man and of animals.
Flora	- Plants on land or in the water.
Fluvial	- Relating to sediment deposition by moving (river) water.
Food Chain	- Movement of food and energy from one form of life to another; for example, algae to zooplankton to fish.
Groin (British, GROYNE)	- A shore protective structure (built usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore. It is narrow in width, and its length may vary from less than one hundred to several hundred feet (extending from a point landward of the shoreline out into the water). Groins may be classified as permeable or impermeable; impermeable groins having a solid or nearly solid structure, permeable groins having openings through them of sufficient size to permit passage of appreciable quantities of littoral drift.
Groundwater	- Water that exists in a saturation zone of the earths crust.
Harbor	- An area of water along the shoreline which is protected and affords anchorage to commercial and recreational water craft.
Impact	- The effect of one thing upon another. "Environmental" impacts may affect any one or combination of elements in the total environment and may be of positive or negative impact and of long or short duration.
Impermeable	- Able to confine water without any seepage.
Interface	- The point at which two substances, such as water and bottom sediments, come together.
Jetty	- A solid structure (somewhat similar in appearance to a boat dock) which projects from the shore for control of longshore drift erosion or sedimentation of the beach.

Lakers	- "Boats" designed and built specifically for hauling bulk cargo such as iron ore, taconite pellets, coal or grain on the Great Lakes. "Average" present day lakers may be between 600 and 700 feet long and about 80 feet wide and carry 10,000 to 20,000 ton loads. New lakers are being built, however, which are 1,000 feet long, 100 feet wide and able to carry 40 to 50 thousand tons.
Latitude	- Distance in degrees north or south of the Equator (0^{o}).
Leach	- To remove a substance by water filtration or percolation.
Lead	- Lead (Pb) a heavy metal which is toxic to life.
Littoral	- The shallow waters that extend along the edge of a lake or sea.
Littoral Deposits	- Deposits of littoral drift.
Littoral Drift	- The bottom materials moved in the littoral zone under the influence of waves and current. Direction of movement or "transport" of littoral materials depends upon wind and wave direction.
Longitude	- Distance in degrees east or west of a line (0^{o}) which passes from north to south through Greenwich, England.
Longshore Current	- Somewhat similar to littoral drift.
Low Water Datum	- LWD. An approximation to the plane of mean low water that has been adopted as a standard reference plane.
Marsh	- A tract of soft, wet or periodically inundated land, generally treeless and usually characterized by grasses and other low growth.
Methylation	- Change from an inorganic to an organic form usually as a result of bacterial action. For example, the metal mercury is relatively non-toxic if eaten; however, methyl-mercury is extremely toxic if eaten and can be transmitted via food chains.

Mercury	- A heavy metal, highly toxic if breathed or ingested. Mercury is residual in the environment, showing biological accumulation in all aquatic organisms, especially fish and shellfish.
mg/Kg	- Milligram per kilogram.
Monitoring Program	- To study the amount of pollutants present in the environment.
Mooring Facility	- A place where a ship is fastened.
Navigation Aids	- Lights, horns, bells, symbols placed and maintained by the U.S. Coast Guard to aid boat and ship navigation. Navigation aids are often placed on the outermost end of Corps breakwaters and piers.
Nekton	- Swimming aquatic insects and fish.
Nutrient	- Elements or compounds essential as raw materials for organism growth and development; for example, carbon, oxygen, nitrogen, and phosphorus.
Oligotrophic	- (Of a lake) weak in production due to a low supply of nutrients, resulting in a clean and clear body of water; in the past, the Great Lakes have been oligotrophic.
Organic	- Material of life origin; leaves, sticks, animals, fish.
Peninsula	- A "Finger" of land projecting out into, and surrounded on three sides by water.
Percolate	- Downward flow or infiltration of water through the pores or spaces of a rock or soil.
Permeable	- Able to allow water to seep through.
pH	- A measure of the relative acid or alkaline state of water. pH is measured on a scale of 0 to 14. A pH of 7 is neutral, a pH below 7 is acid, a pH above 7 is alkaline. Rainwater is usually slightly acid.

Phenols	- A group of organic compounds that in very low concentrations produce a taste and odor problem in water.
Phosphorus	- An element that while essential to life, contributes to the eutrophication of lakes and other bodies of water.
Phytoplankton	- The plant portion of plankton.
Piers	- Permanent structures constructed of stone, steel, cement or a combination of those materials, which are used to define and stabilize entry channels from the open lake into a harbor.
Plankton	- Small aquatic plants and animals whose movement is controlled by river, harbor and lake currents.
Pocket Harbor	- A harbor which does not have a river or stream flowing through it, which carries and deposits sediment loads.
Pollution	- Any change in water quality that impairs it for the subsequent user. These changes result from contamination of the physical, chemical, or biological properties of water.
Port	- A point (usually a harbor) at which ships load and unload commercial cargo.
ppm	- Parts per million.
ppb	- Parts per billion.
Pumpout Station	- A temporary dock where a connection is made between land and dredge piles; a booster pump may be used.
Revetment	- A permanent structure built of sheet steel piling or concrete placed to keep channel or harbor banks from caving into the water.
Riparian Right	- The right of an owner of land bordering on a stream or lake to have access to, and use of, the shore and water. The use of this water is restricted to riparian landowners, and the right is automatic, not created by use or forfeited through disuse.
Riprap	- A layer, facing, or protective mound of stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment; also the stone so used.

Scientific nomenclature - Scientific nomenclature of animals requires (1) that each species and genus found in the world shall have a name that is independent of change, such as pertains to common names used in many languages; (2) that each species and genus shall have separate names duplicated by none which refer to some other species or genus; and (3) that different names shall not be applicable to any one species or genus. The following is a breakdown of Categories of Higher Rank than Species and Genus:

Kingdon
Phylum
Class
Order
Family
Tribe
Genus
Species

Scow - A barge equipped with trap-doors in its bottom which is used for moving and dumping dredge spoil.

Secchi Disc - An eight inch diameter disk, divided into alternate black and white quadrants supported from its center by a hand line, which is dropped into the water to visually gauge light penetration.

Sediments - Clay, sand, gravel or stones which have been eroded from the land or from beneath the water, have been transported by river or lake currents, and re-deposited.

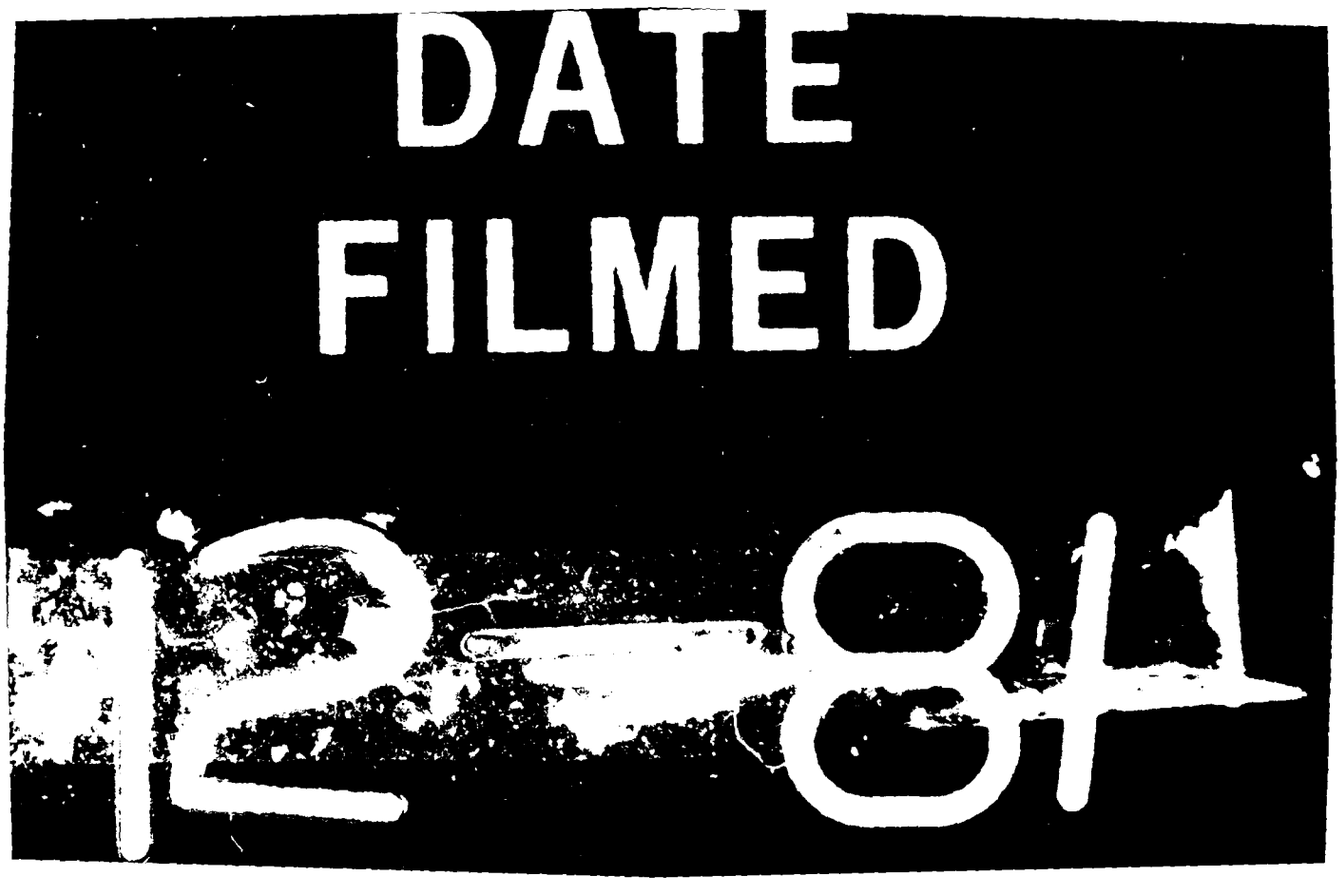
Seawall - A structure separating land and water areas primarily designed to prevent erosion and other damage due to wave action.

Seiche - Fluctuations above or below "normal" water level caused by wind, barometric pressure or a combination of both. A seiche usually does not last for more than several hours at any particular time or place.

Sheet Steel Piling - Interlocking lengths of steel driven into a stream, lake or harbor bottom next to the shore to prevent storm, wave or ship damage.

Shoal	- A place where water is shallow, sometimes created by a sandbar, in the shipping channels, created by deposition of eroded material.
Shoreline Protection	- Structural measures designed for placement along the shore to relieve erosion and flooding damages. Examples of structural measures are protective beaches, seawalls, groins and revetments.
Side Casting	- The disposal of dredged sediments off to the side of the channel or basin being dredged. Side cast disposal may be either in the water or on land.
Silt	- Finely divided particles of soil or rock. Often carried in cloudy suspension in water and eventually deposited as sediment.
Spoil	- Sediments which have been dredged from beneath the water.
Stagnation	- Lake of motion in the water that tends to entrap and concentrate pollutants.
Substrate	- Any substance used as an attachment point by a microorganism.
Surface Water	- Atmospheric water that runs off to collect in streams, ponds, or lakes, swamps, etc.
Tender	- A boat smaller and less powerful than a tug, but used in essentially the same way.
Tertiary	- Third in order in terms of importance. Also, refers to a final or ultimate process or effect which is dependent upon those processes or effects which have gone before.
TKN	- Total Kjeldahl Nitrogen. A measure of the ammonia and organic nitrogen, but does not include nitrite and nitrate.
Topography	- The configuration of a surface including its relief, the position of its natural and man-made features.
Tug	- A boat with a powerful motor used to move barges, dredges or other boats or ships.
Turbidity	- A cloudy condition in water due to the suspension of silt or finely divided organic matter.

Volatile Solids (Total)	- A measure of the organic material that could decompose and thus exert an oxygen demand on a body of water.
Van Dorn Bottle	- A glass water sampling device which is constructed differently but is used in essentially the same manner as a Kemmerer.
Water Quality Criteria	- The level of pollutants, with respect to the chemical, physical, and biological characteristics, that affect the suitability of water for a given use.
Wave	- A ridge, deformation, or undulation of the surface of a liquid.
W.E.S.	- Waterways Experiment Station of the U. S. Army Corps of Engineers at Vicksburg, Mississippi.
Wharf	- A (permanent) structure alongside a channel or harbor edge to which a boat or ship can tie up.
Zinc	- Zinc (Zn) is a heavy metal which in trace quantities is essential to life, but which in greater quantities may be toxic to life.
Zooplankton	- Planktonic animals that supply food for fish.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